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TM 9-1718 D

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

ORDNANCE MAINTENANCE

HYDRAULIC TURRET TRAVERSING MECHANISM (OILGEAR) FOR MEDIUM TANK M46

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DEPARTMENT OF THE ARMY • AUGUST 1950

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HYDRAULIC TURRET TRAVERSING MECHANISM (OILGEAR) FOR MEDIUM TANK M46

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The Adjutant General

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For explanation of distribution formula see SR 310–90–1.

CONTENTS

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. These instructions are published for the information and guidance of personnel responsible for field and for depot maintenance of this matériel. They contain information on maintenance which is beyond the scope of the tools, equipment, or supplies normally available to using organizations. This manual does not contain information which is intended primarily for the using organization, since such information is available to ordnance maintenance personnel in the pertinent operator's technical manuals or field manuals.

b. This manual contains a description of and procedures for removal, disassembly, inspection, repair, rebuild, and assembly of the hydraulic turret traversing mechanism (Oilgear) for the medium tank M46. The appendix contains a list of current references, including supply catalogs, technical manuals, and other available publications applicable to the matériel.

c. TM9–718 contains operating and lubricating instructions for the materiel, and contains all maintenance operations allocated to using organizations in performing maintenance work within their scope.

d. This first edition is being published in advance of review by all concerned. It is requested that any errors and omissions be brought to the attention of Chief of Ordnance, Washington 25, D. C., ATTN: ORDFM-Pub.

2. Field and Depot Maintenance Allocation

The publication of instructions for complete disassembly and rebuild is not to be construed as authority for the performance by field maintenance units of those functions which are restricted to depots and arsenals. In general, the prescribed maintenance responsibilities will apply as reflected in the allocation of tools and maintenance parts listed in the appropriate columns of the current ORD 8 supply catalog pertaining to this matériel. Instructions for depot maintenance are to be used by maintenance companies in the field only when the tactical situation makes the repair functions imperative. Provisions of parts listed in the depot-stock-guide column of ORD 8 supply catalogs will

be made to field maintenance units only when the emergency nature of the maintenance to be performed has been certified by a responsible officer of the requisitioning organization.

3. Forms, Records, and Reports

a. General. Forms, records, and reports are designed to serve necessary and useful purposes. Responsibility for the proper execution of these forms rests upon commanding officers of all units maintaining this equipment. It is emphasized, however, that forms, records, and reports are merely aids. They are not a substitute for thorough practical work, physical inspection, and active supervision.

b. Authorized Forms. The forms, records, and reports generally applicable to units maintaining this equipment are listed in the appendix. No forms other than approved Department of the Army forms will be used. Pending availability of forms listed, old forms may be used. For a current and complete listing of all forms, see current SR 310–20–6.

c. Report of Injury to Personnel or Damage to Matériel. The reports necessary to comply with the requirements of the Army safety program are prescribed in detail in the SR 385–10–40 series of special regulations. These reports are required whenever accidents occur involving injury to personnel or damage to matériel.

d. Report of Unsatisfactory Equipment or Materials. Any suggestions for improvement in design, maintenance, safety, and efficiency of operation prompted by chronic failure or malfunction of the matériel, spare parts, or equipment or as to defects in the application or effect of prescribed petroleum fuel, lubricants, and/or preserving materials will be reported through technical channels as prescribed in SR 700–45–5 to the Chief of Ordnance, Washington 25, D. C, ATTN: ORDFM, using DA AGO Form 468, Unsatisfactory Equipment Report. Such suggestions are encouraged in order that other organizations may benefit.

Section II. DESCRIPTION, PRINCIPLE OF OPERATION, AND DATA

4. Description

(fig. 1)

a. General. The hydraulic turret traversing mechanism consists of a two-way variable-delivery hydraulic pump, a constant-displacement hydraulic motor, a traversing gear mechanism, an oil reservoir, gunner's manual and power traversing controls, a crew commander's power traversing control, and necessary turing, hose and fittings. It enables the gunner or commander to traverse and train the turret quickly and accurately with a minimum of effort. Fluid power is supplied by a two-way variable-delivery hydraulic pump to a con-

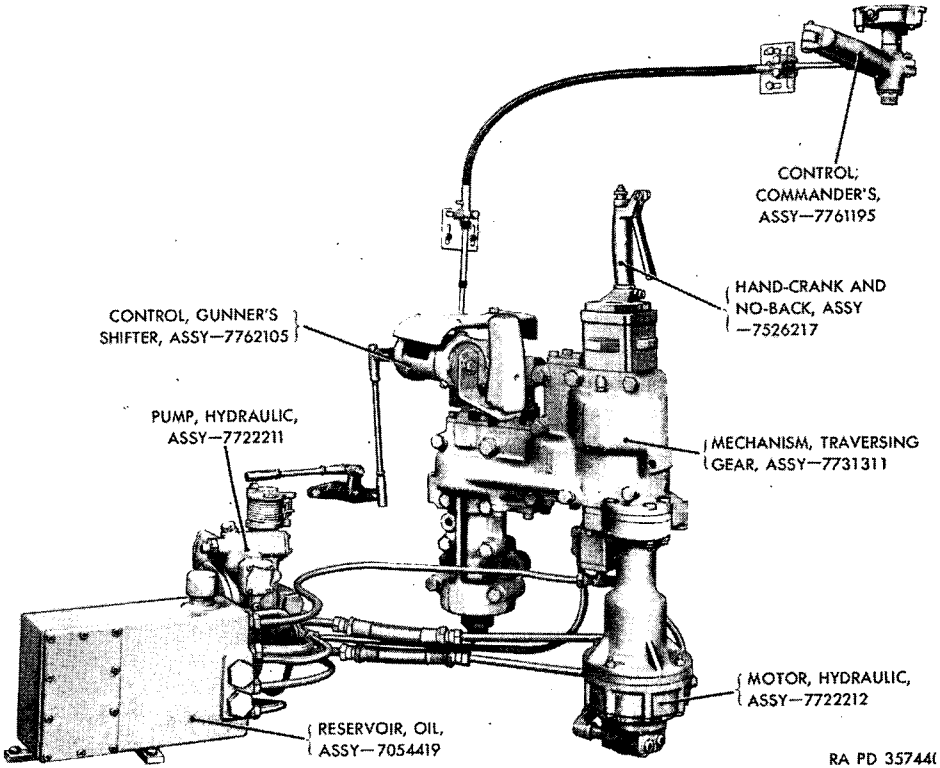


Figure 1. Hydraulic turret traversing mechanism.

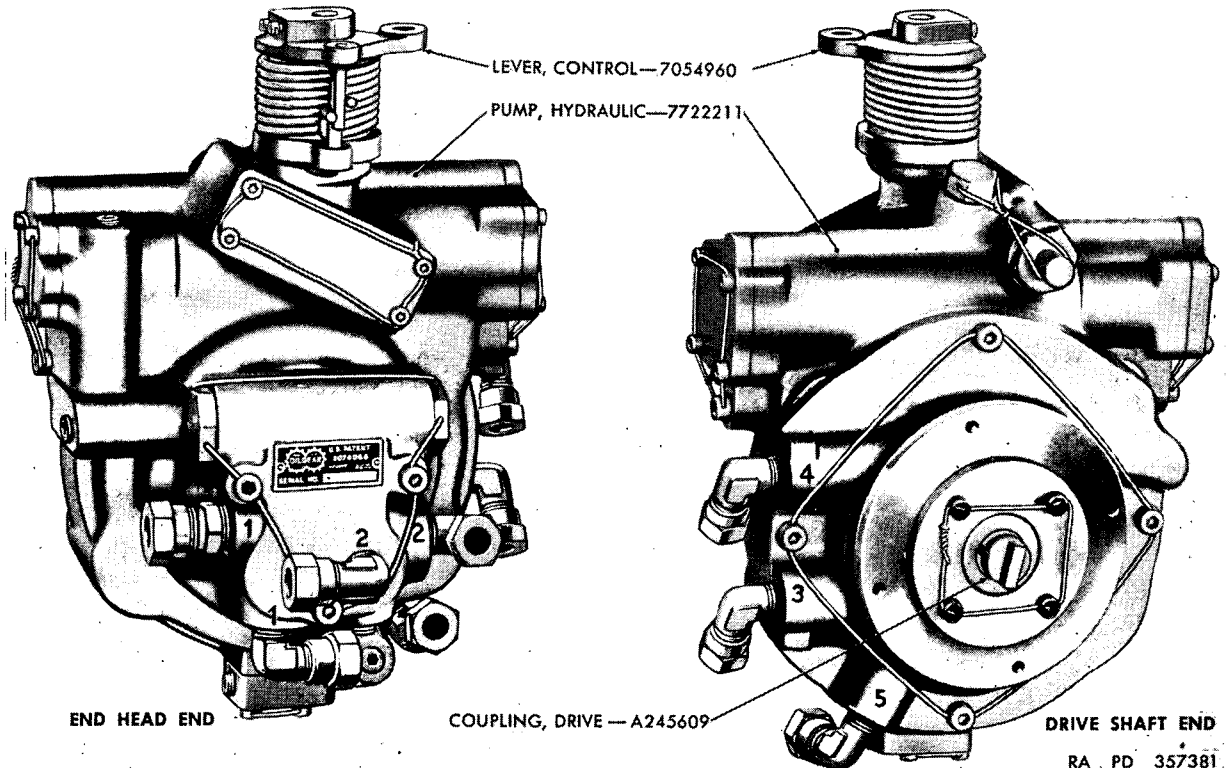


Figure 2. Front and rear view of variable-delivery hydraulic pump.

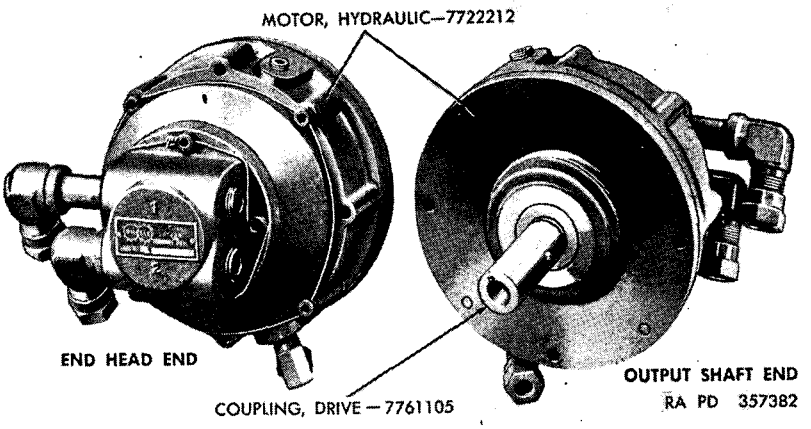


Figure 3. Front and rear view of constant-displacement hydraulic motor.

stant-displacement hydraulic motor, and controlled by hand-grip handles, convenient to the gunner and crew commander. Commander's control has precedence over gunner's control. This controlled drive traverses the turret 360° in either direction, at any speed up to maximum, through a traversing gear mechanism and a ring gear. The two-way variable-delivery hydraulic pump, with its hydraulic servo-motor lever control, permits rapid traverse for following a fast moving target. It permits quick reversal for changing targets. It permits slow rotation in either director for following a stationary target when tank is in motion or when gunner is making fine adjustments on telescopic sights. Through gunner's hand grip handle, or commander's hand grip handle, turret guns can be accurately sighted on a stationary or moving target when tank is in motion. Characteristics inherent in the hydraulic turret traversing mechanism are—Continuously variable speed control in either direction; rapid acceleration or deceleration in either direction; hydro-dynamic braking; automatic protection against overloading drive mechanism; pressure and flood lubrication of all working parts in the hydraulic pump and the hydraulic motor with oil in the system.

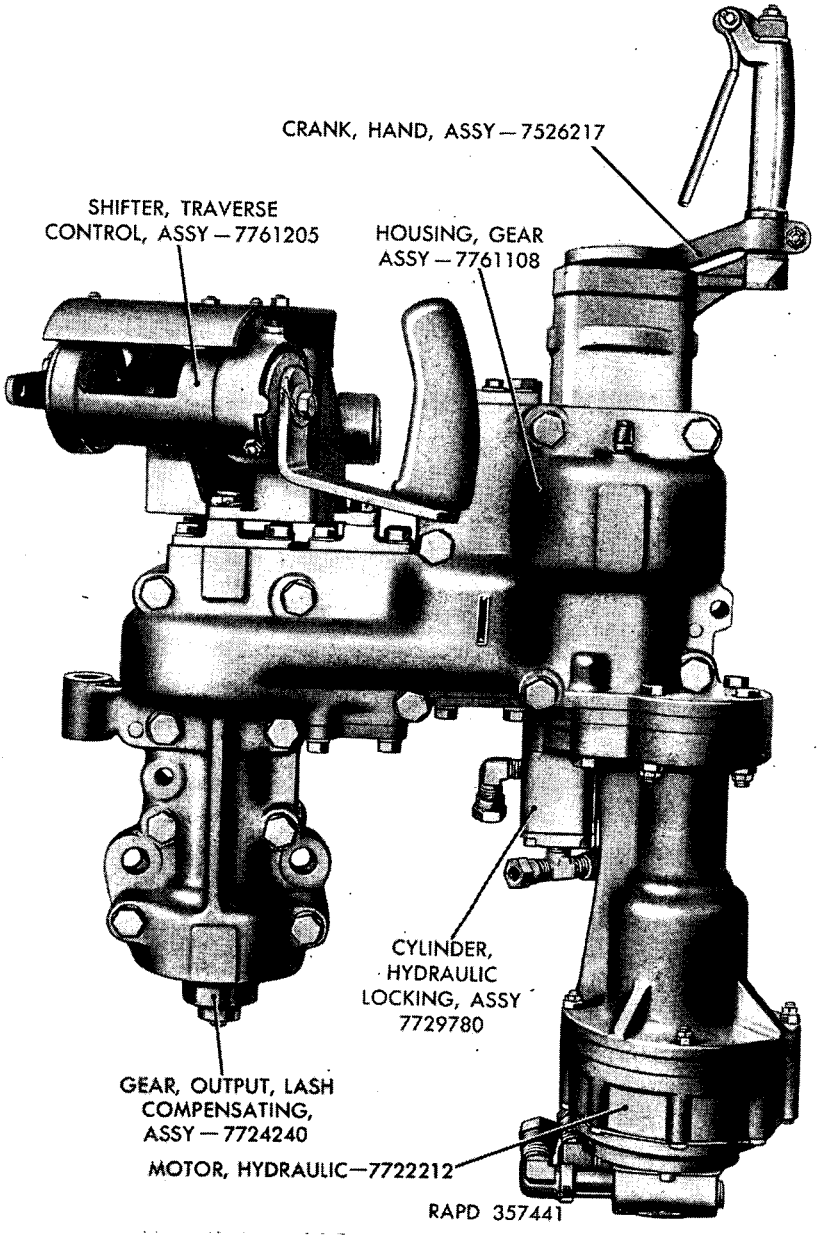


Figure 4. Front of traversing gear mechanism.

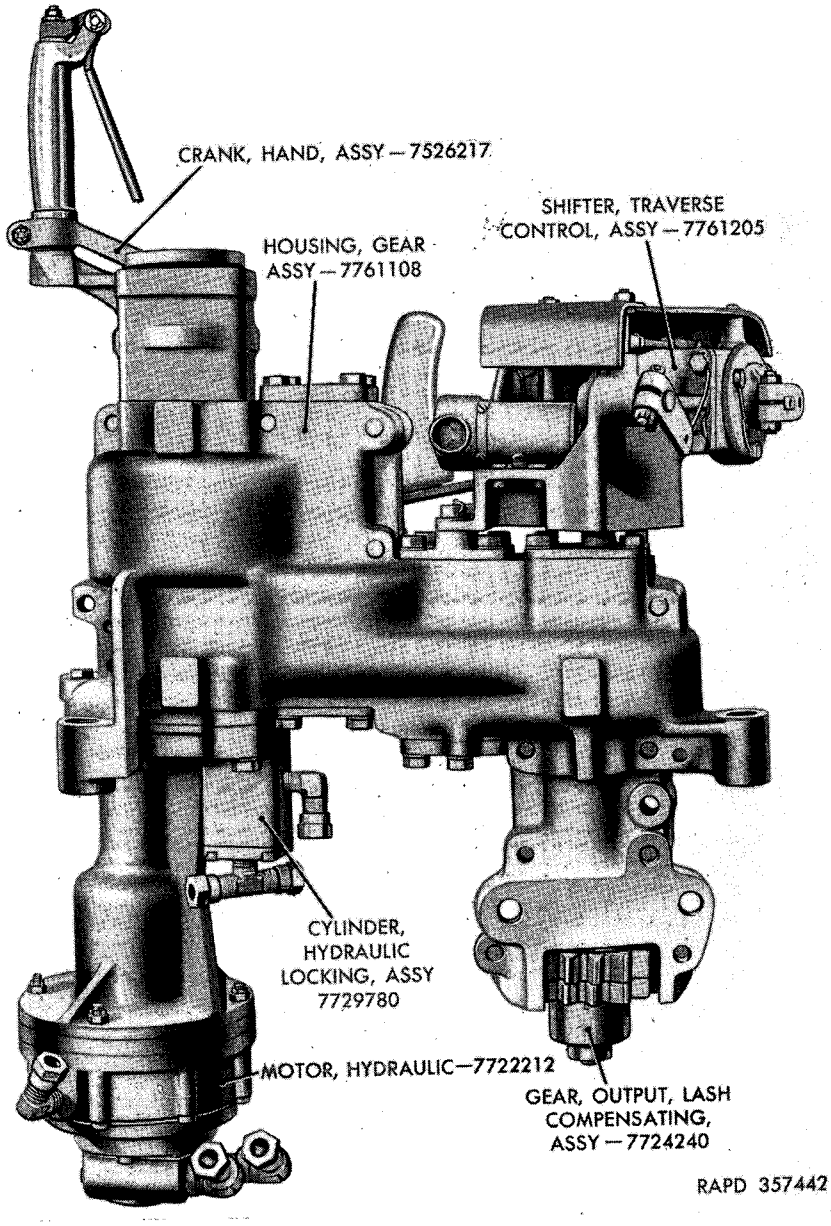


Figure 5. Rear of traversing gear mechanism.

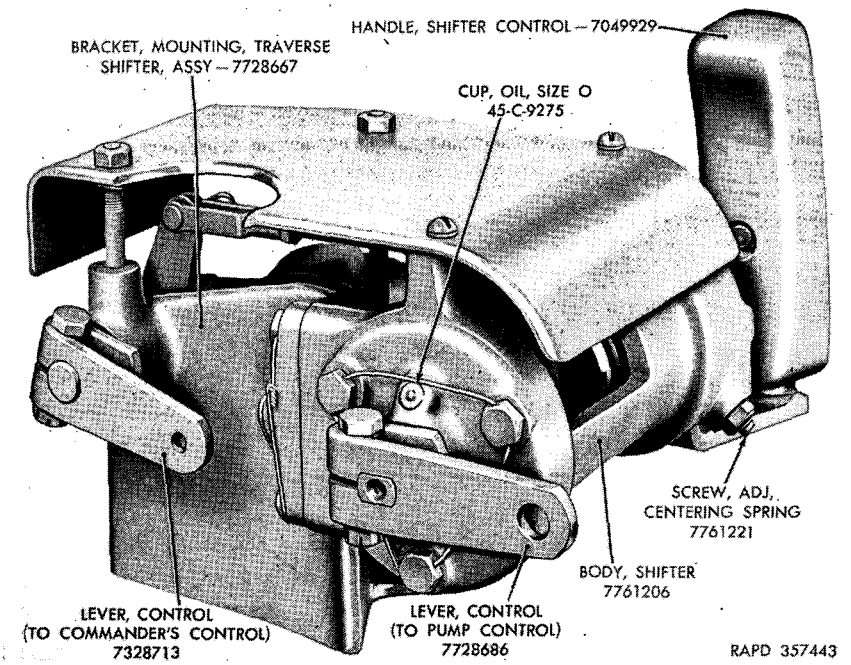


Figure 6. Gunner's control.

b. Principal Components (figs. 1, through 10). The hydraulic turret traversing system is comprised of a two-way variable-delivery hydraulic pump, a constant-displacement hydraulic motor, a traversing gear mechanism, an oil reservoir, gunner's manual and power traversing controls, a crew commander's power traversing control, and the necessary tubing, hose, and fittings. An electric motor drives the hydraulic pump counterclockwise at a constant speed, when viewed from pump drive shaft end. The hydraulic pump is bolted to the electric motor. The electric motor and oil reservoir are mounted to a common bracket inside the turret basket. The constant-displacement hydraulic motor is bolted to the traversing gear mechanism. The turret drive pinion on the traversing gear mechanism engages the turret ring gear. The volume of oil delivered by the hydraulic pump is variable from zero to maximum in either direction and flows directly to and from the hydraulic motor. The hydraulic motor drives the gear train in the traversing gear mechanism which, in turn, rotates the turret. A no-back mechanism automatically holds turret in position when hydraulic motor stops, and prevents turret drift when tank is not in horizontal position. A spring-loaded, hydraulically actuated pistol locks power driven gear when hydraulic pump is not operating.

c. Manual Traversing Mechanism (figs. 4 and 5). In case of power failure, the gunner or commander can traverse the turret by

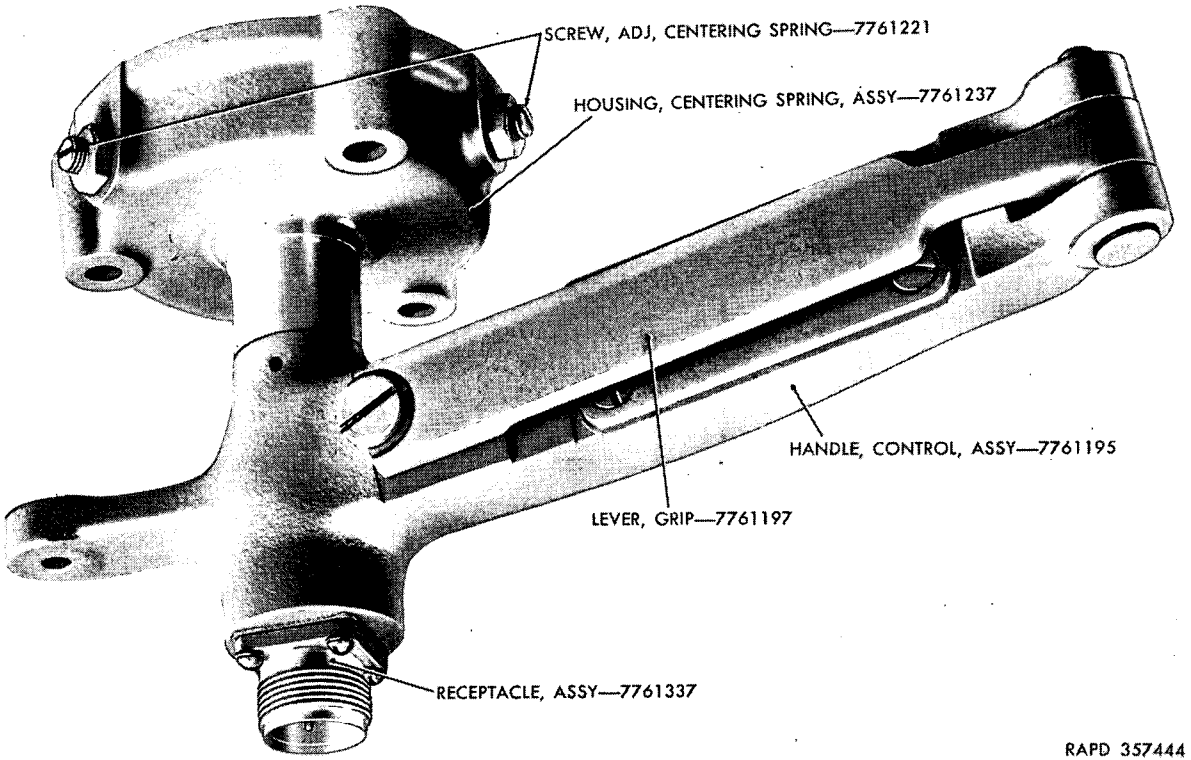


Figure 7. Crew commander's control.

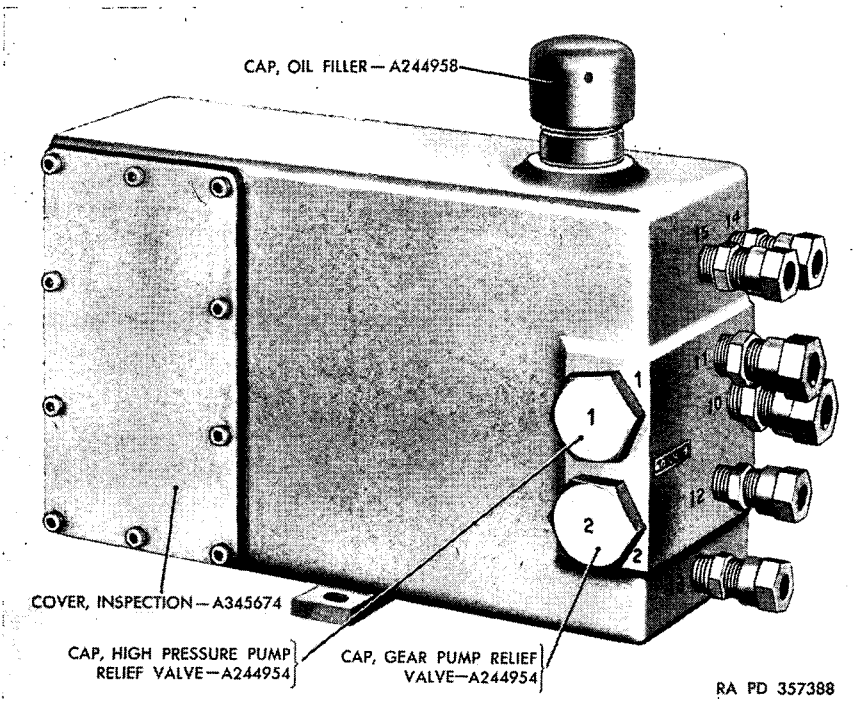


Figure 8. Oil Reservoir.

rotating the hand traverse mechanism mounted on top of the traversing gear mechanism Gripping the hand crank and the grip lever and rotating hand crank clockwise traverses turret clockwise. Rotating hand crank counterclockwise traverses turret counterclockwise. When hand crank is stopped, a no-back mechanism automatically holds turret in position and prevents turret drift when tank is not in a horizontal position. Releasing the grip lever over stop bushing engages spindle and keeps hand crank in the idle position.

5. Principle of Operation

a. Hydraulic Pump (figs. 2, 16, and 17). The ported drive shaft—with integral cylinder and 14 rolling pistons—is driven counterclockwise by an electric motor through a coupling. Centrifugal force, combined with the pressure in the hydraulic system, keeps the beveled surfaces of the rolling pistons against the inner race of the roller bearing. Through contact of the rolling pistons, the inner race rotates with the cylinder and the ported drive shaft. The slide block race,

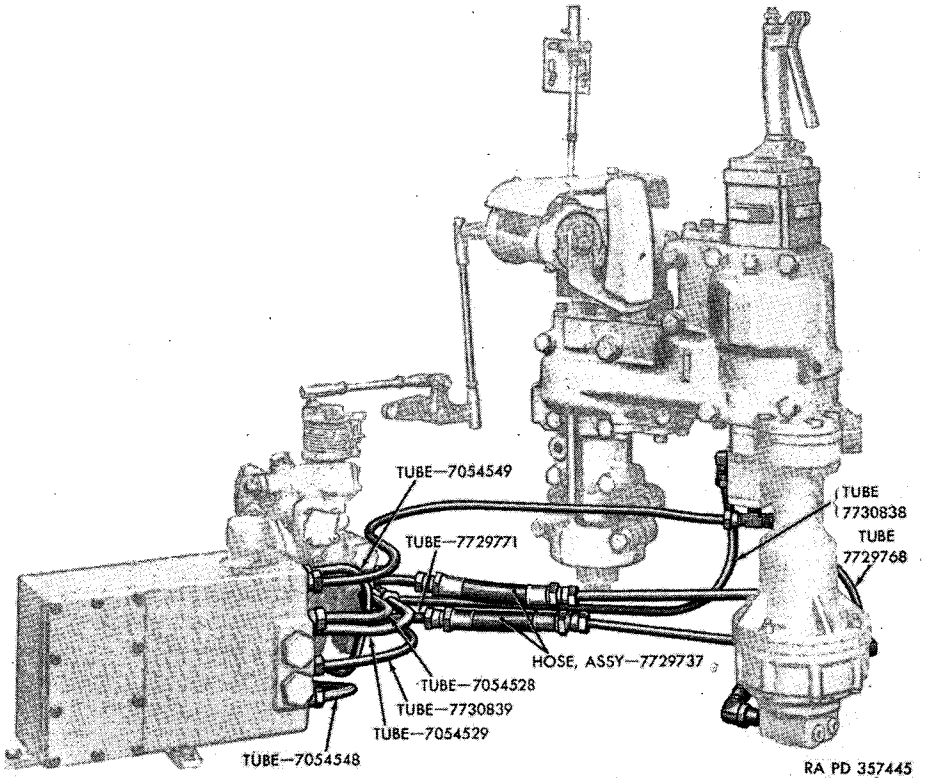


Figure 9. Front view of hydraulic turret traversing mechanism tubing, hose, and fittings.

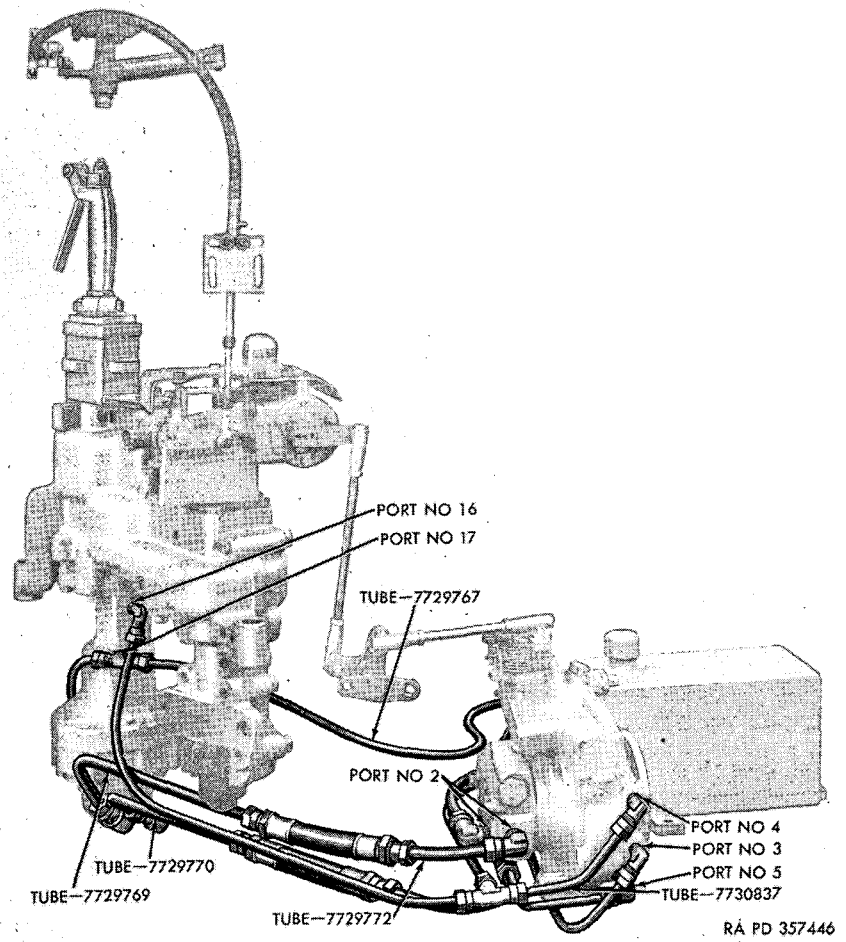


Figure 10. Rear view of hydraulic turret traversing mechanism tubing, hose, and fittings.

which moves on two slide block race caged rollers between ground surfaces on the race and plates in the pump case, is moved to the right or left of the ported drive shaft axis by a hydraulically operated control cam, slide block back-up piston, and slide block back-up piston spring. Increasing the eccentricity of the slide block race increases the stroke of the rolling pistons and the volume of oil discharged. Reversing the eccentricity of the slide block race reverses the direction of oil flow. When the center line of drive shaft and slide block race do not coincide, the differences between the radii from the center of the drive shaft to the points of contact of the pistons with the inner race of the roller bearing cause the rolling pistons to move faster or slower than their points of contract with the inner race of the roller bearing. This difference in speed is adjusted by slow, partial rotation of each

piston in its cylinder bore—in one direction during the one-half revolution and in the opposite direction during the other half revolution. The pistons thus rotate and reciprocate, simultaneously. Oil flow to and from the rolling pistons through machined passages in the pump end head, back-up pistons, hold-down tumblers, flat valve, drive shaft, and cylinder.

b. Hydraulic Pump Control (figs. 2, 16, 19, 20, 43, and 44). An eccentric control shaft (fig. 20) actuated by the spring-centered control lever depresses or releases the equalizing bar and the spring-loaded pilot valve plunger (fig. 19) to allow oil from the gear pump to actuate the control cam pistons and control cam. See figures 11, 12, and 13 for the flow of oil from gear pump to pilot valve. When the spring-centered control lever is at rest, which is the neutral position (fig. 11), oil from the gear pump flows through drilled passages in the case to the small control piston and pilot valve, but cannot actuate the control cam because oil in back of the large control cam piston is blocked by the spring-loaded pilot valve plunger (fig. 19). The flow of gear pump oil to the large control cam piston also is blocked by the pilot valve plunger. When the spring-centered control lever is moved to position "C" (fig. 13), the eccentric control shaft releases the equalizing bar and the spring-loaded pilot valve plunger, allowing the oil behind the large control cam piston to drain into the pump case and out port 5 to the oil reservoir, while the gear pump oil, acting on the small control cam piston, moves the control cam upward to the position shown in figure 13. As the control cam moves upward, the follow-up pin forces the end of the equalizing bar outward against the eccentric control shaft, acting as a fulcrum, and forces the spring-loaded pilot valve plunger inward until the oil passage from the large control cam piston is blocked. Movement of the control cam upward is always proportional to the movement of the spring-centered control lever through arc "A–C." When the spring-centered control lever is moved to position "B" (fig. 12), the eccentric control shaft depresses the equalizing bar and the spring-loaded pilot valve plunger, allowing the gear pump oil to flow to the large control cam piston and to move the control cam downward to the position shown in figure 12. As the control cam moves downward, one end of the equalizing bar follows the follow-up pin inward, while the pilot valve plunger spring moves the pilot valve plunger and other end of the equalizing bar outward, until the oil passage leading to the large control cam piston is blocked. When this passage is blocked, movement of the control cam is stopped. Movement of the control cam downward is always proportional to the movement of the spring-centered control lever through arc "A–B."

c. Hydraulic Pump Back-up Piston (figs. 16 and 43). Oil pressure from the radial piston pump acting on the slide block back-up piston, combined with the force of the slide block back-up spring

keeps the nose of the slide block race against the face of the conrol cam. A control cam back-up roller supports the back of the control cam.

d. Hydraulic Pump Gear Pump (figs. 17 and 38). Gear pump gears suck oil from port 13 in reservoir through pump port 3 and discharge the oil through drilled passages in the case to the pilot valve for operating the control cam pistons, and through drilled passages to the end head for supercharging and lubricating the radial piston pump through the check valves. Gear pump oil also is delivered to the cylinder on traversing gear mechanism to automatically disengage locking pin from hydraulic motor driven gear.

e. Relief Valves (figs. 8, 28, and 112). Relief valves consisting of plungers, springs, bushings, and seats, for limiting the gear pump low pressure and the radial piston pump high pressure, are built into the oil reservoir (fig. 28).

f. Hydraulic Motor (figs. 3, 21, and 22). The ported drive shaft, with integral cylinder and 14 rolling pistons, is driven counterclockwise or clockwise by oil under pressure delivered by the two-way, variable-delivery hydraulic pump. Oil delivered to port 1 of hydraulic motor flows through the end head, large back-up piston, hold-down tumbler, upper crescent in flat valve, and through ports in drive shaft connected to upper crescent to force the rolling pistons passing through the arc of the upper flat valve crescent outward, causing the inner race of the roller bearing, cylinder, and drive shaft to rotate counterclockwise, when facing end of drive shaft. Oil discharged by the rolling pistons, passing through the arc of the lower flat valve crescent, flows through ports in the drive shaft, flat valve, two small hold-down tumblers, two small back-up pistons and out of hydraulic motor port 2. Oil delivered to port 2 of hydraulic motor flows through the end head, two small back-up pistons, hold-down tumblers, lower crescent in flat valve, and through ports in drive shaft connected to lower crescent, to force the rolling pistons passing through the arc of the lower flat valve crescent outward, causing the inner race of the roller bearing, cylinder, and drive shaft to rotate clockwise, when facing end of drive shaft. Oil discharged by the rolling pistons, passing through the arc of the upper flat valve crescent, flows through ports in the drive shaft, flat valve, large hold-down tumbler, back-up piston and out of hydraulic motor port 1. Since the center lines of the ported drive shaft and the roller bearing do not coincide, the differences between the radii from the center of drive shaft to the points of contact of the rolling pistons with the inner ring of the roller bearing cause the rolling pistons to move faster or slower than their points of contact with the inner ring of the roller bearing. This difference in speed is adjusted by slow, partial rotation of each rolling piston in its bore, in one direction during one-half revolution and in the opposite direction during the other half

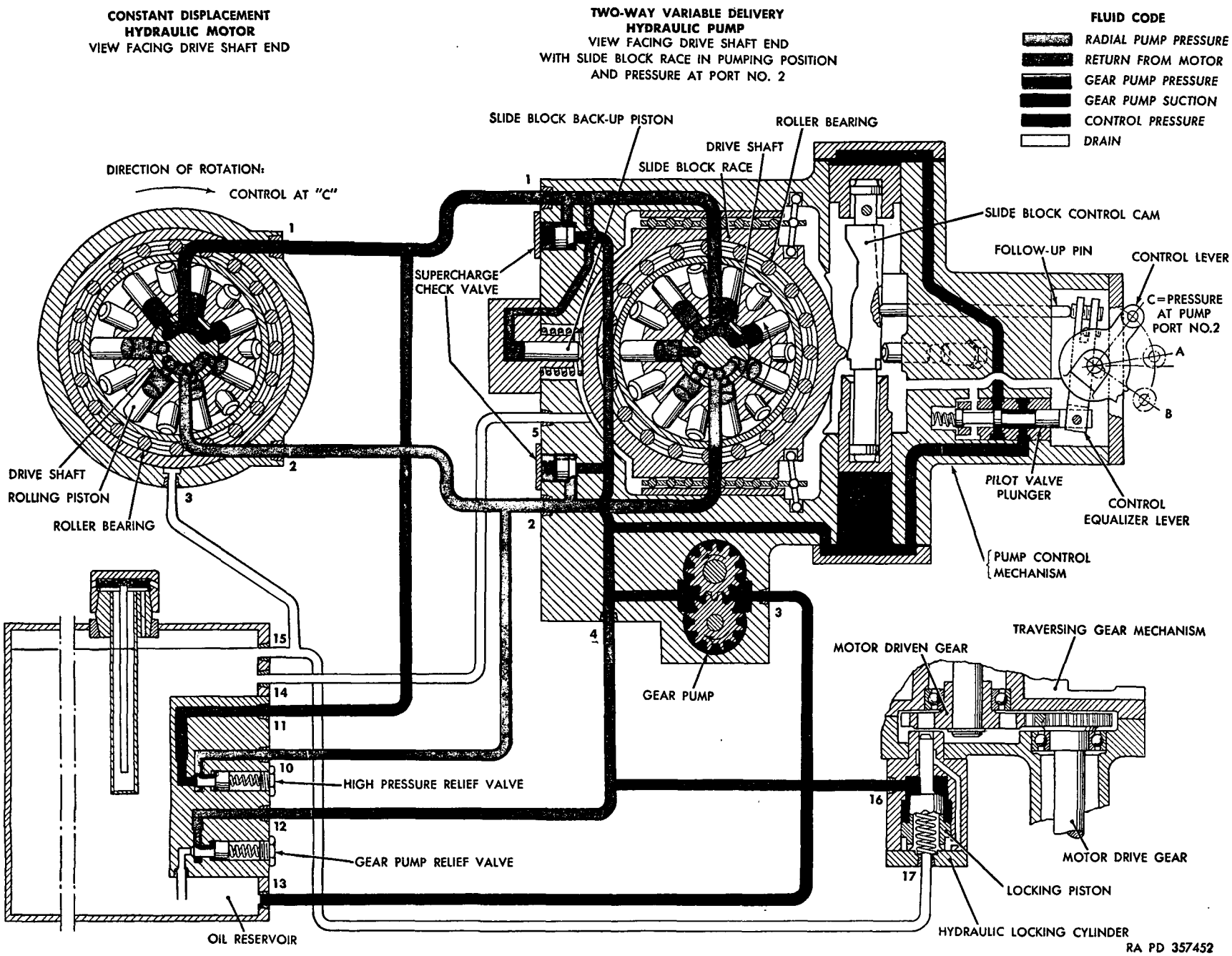


Figure 13. Hydraulic turret traversing mechanism oil circuit (clockwise rotation).

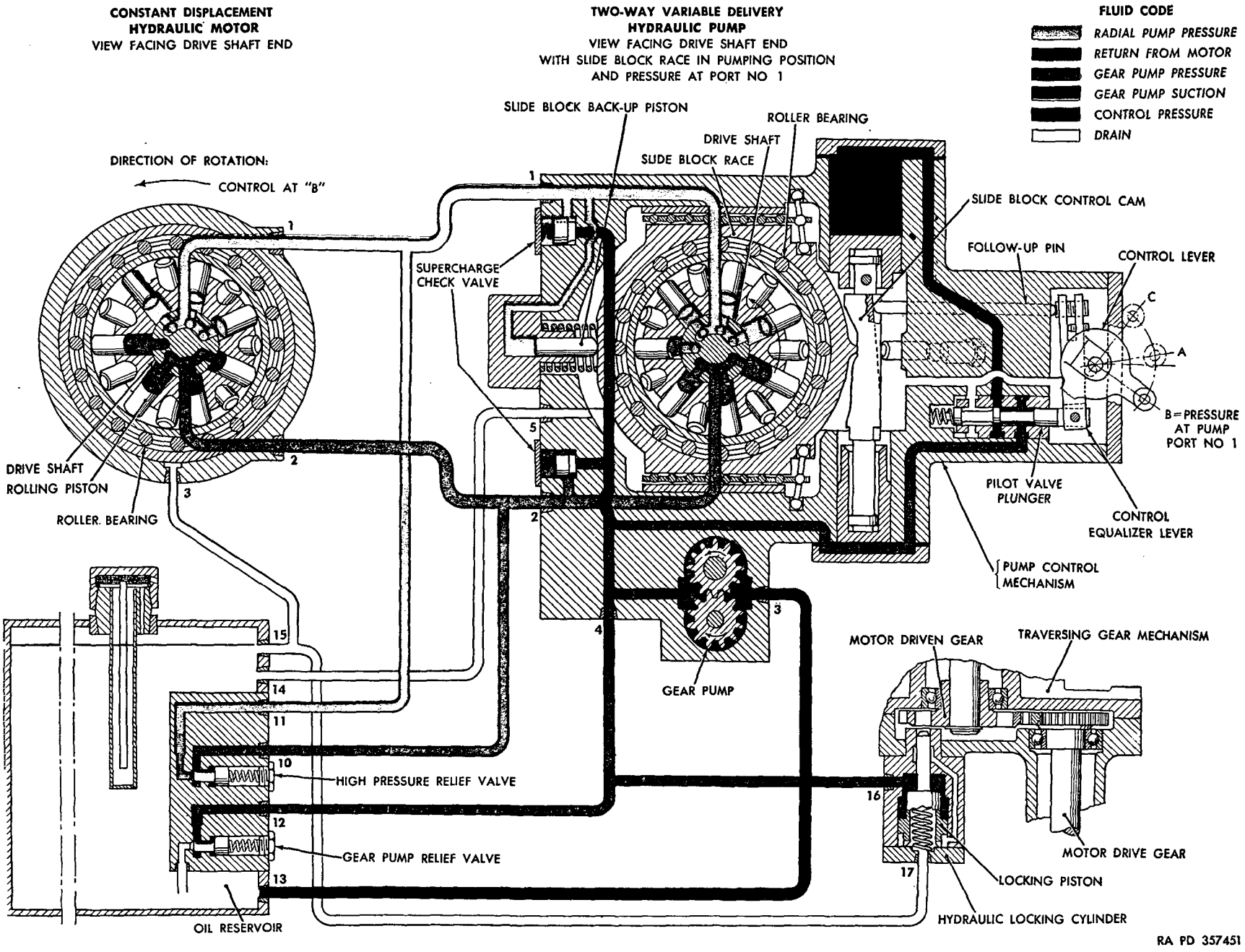


Figure 12. Hydraulic turret traversing mechanism oil circuit (counterclockwise rotation).

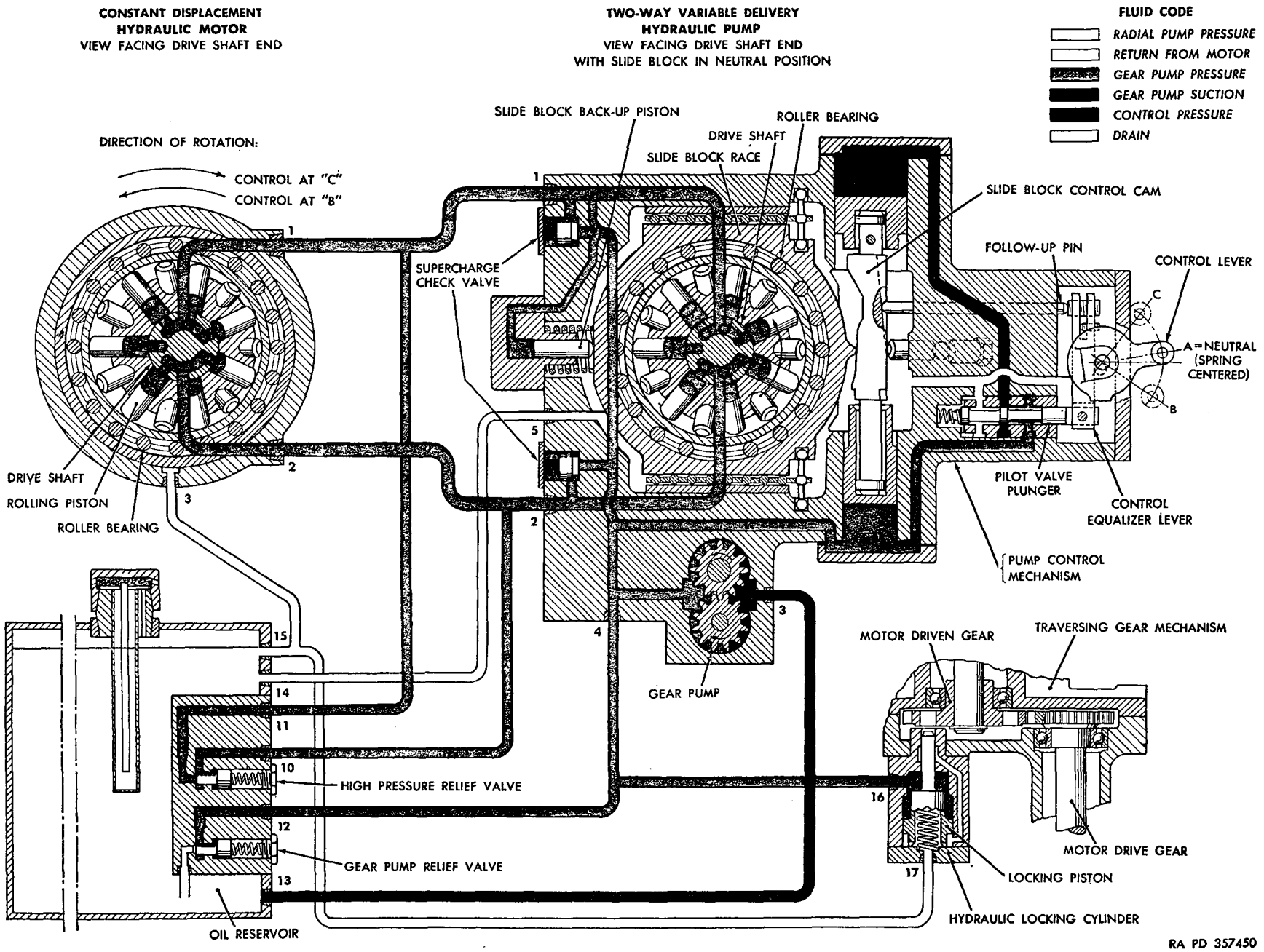


Figure 11. Hydraulic turret traversing mechanism oil circuit (neutral).

revolution of drive shaft. Thus, the rolling pistons rotate and reciprocate, simultaneously. Centrifugal force, plus the pressure in the system, keeps the rolling pistons in contact with the inner race of the roller bearing. Internal slip and leakage lubricates the working parts and then drains out of hydraulic motor port 3 to the oil reservoir.

g. Oil Reservoir (figs. 8 and 28). Oil from the rectangular reservoir is used as the fluid power medium in the hydraulic turret traversing mechanism system. A built-in low-pressure relief valve limits the discharge pressure of the gear pump and directs the excess oil to the reservoir. A built-in high-pressure relief valve limits the discharge pressure of the radial rolling piston pump and protects traverse system against overload. Oil discharged from port 1 of the hydraulic pump, at a pressure slightly in excess of the high-pressure relief valve setting, discharges past the relief valve plunger, and flows back to radial-piston pump through port 2. Oil discharged from port 2 of the hydraulic pump, at a pressure slightly in excess of the high-pressure relief valve setting, discharges past the relief valve plunger and flows back to radial piston pump through port 1.

h. Neutral. When pump control lever is in neutral position (fig. 11), the center lines of drive shaft and slide block race coincide and no reciprocating motion is imparted to the rolling pistons. Thus, as the shaft and pumping unit rotate, no oil is delivered by the pump to the hydraulic motor, so the turret remains stationary. Oil delivered by the gear pump lubricates and supercharges the radial piston pump and the excess oil discharges past the relief valve plunger into the oil reservoir.

i. Counterclockwise Rotation. When pump control lever is turned clockwise to position "B" (fig. 12), the roller bearing and the slide-block race are moved to the right by the hydraulically operated control cam and slide block race back-up piston, reciprocating motion is so imparted to the rolling pistons that those passing through the arc of the upper crescent passage in flat valve deliver oil to that crescent passage, to the two small hold-down tumblers, and back-up pistons, and oil is discharged out port 1 to port 1 of the hydraulic motor. Oil entering port 1 of the hydraulic motor flows through the end head, large back-up piston, hold-down tumbler, upper crescent in flat valve, and through ports in drive shaft connected to upper crescent to force the rolling pistons passing through the arc of the upper flat valve crescent outward, causing the inner race of the roller bearing, cylinder, and drive shaft to rotate counterclockwise, when facing end of drive shaft. Oil discharged by the rolling pistons, passing through the arc of the lower flat valve crescent, flows through ports in the drive shaft, flat valve, two small hold-down tumblers, two small back-up pistons, and out hydraulic-motor port 2 to port 2 of the hydraulic pump. Those rolling pistons passing through the arc of the lower

crescent passage in the pump flat valve are sucking or filling up with oil, flowing in hydraulic pump port 2, and through the large back-up piston, hold-down tumbler, and lower crescent. Oil from the gear pump supercharges the oil flowing to the lower crescent through the lower check valve. The volume of oil delivered and the counterclockwise rotation of the hydraulic motor shaft increase proportionately with the increase of eccentricity of the hydraulic pump slide block race.

j. Clockwise Rotation. When pump control lever is turned counterclockwise to position "C" (fig. 13), the roller bearing and the slide block race are moved to the left by the hydraulically operated control cam; reciprocating motion is so imparted to the rolling pistons that those passing through the arc of the lower crescent passage in the flat valve deliver oil to that crescent passage, to the large hold-down tumbler, and back-up piston and oil is discharged out port 2 to port 2 of the hydraulic motor. Oil entering port 2 of the hydraulic motor flows through the end head, and through two small back-up pistons, hold-down tumblers, and lower crescent in flat valve, and through ports in drive shaft connected to lower crescent, forcing outward the rolling pistons passing through the arc of the lower crescent in flat valve, causing the inner race of the roller bearing, cylinder, and drive shaft to rotate clockwise, when facing end of drive shaft. Oil discharged by the rolling pistons passing through the arc of the upper crescent in flat valve flows through the ports in drive shaft, flat valve, large hold-down tumbler, back-up piston, and out motor port 1 to port 1 of the hydraulic pump. Those rolling pistons passing through the arc of the upper crescent passage in the pump flat valve are sucking or filling up with oil, flowing in hydraulic pump port 1, and through two small back-up pistons, hold-down tumblers, and upper crescent. Oil from the gear pump supercharges the oil flowing to the upper crescent through the upper check valve. The volume of oil delivered and the clockwise rotation of the hydraulic motor shaft increase proportionately with the increase of eccentricity of the hydraulic pump slide block race.

6. Data

Maximum turret traversing speed in either direction is 4¼ rpm.

CHAPTER 2

PARTS, SPECIAL TOOLS, AND EQUIPMENT FOR FIELD AND DEPOT MAINTENANCE

7. Parts, Tools, and Equipment

a. GENERAL. Tools and equipment and additional spare parts, over and above those available to the using organization, are supplied to ordnance field maintenance units and depots for maintaining, repairing, and/or rebuilding the matériel.

b. PARTS. Parts are listed in Department of the Army Supply Catalog ORD 8 SNL G–244, which is the authority for requisitioning replacements. Parts not listed in an ORD 8 catalog, but required by depot shops in rebuild operations may be requisitioned from the listing in the corresponding ORD 9 catalog.

c. COMMON TOOLS AND EQUIPMENT. Standard and commonly used tools and equipment having general application to this matériel, are listed in Department of the Army Supply Catalog ORD 6 SNL G–27, section II, which is the authority for requisitioning replacements. They are not identified specifically in this manual.

8. Special Tools and Equipment

The special tools and equipment tabulated in table I are listed in Department of the Army Supply Catalog ORD 6 SNL G–27, section I. The tabulation contains only those special tools and equipment necessary to perform the operations described in this manual, is included for information only, and is not to be used as a basis for requisitions.

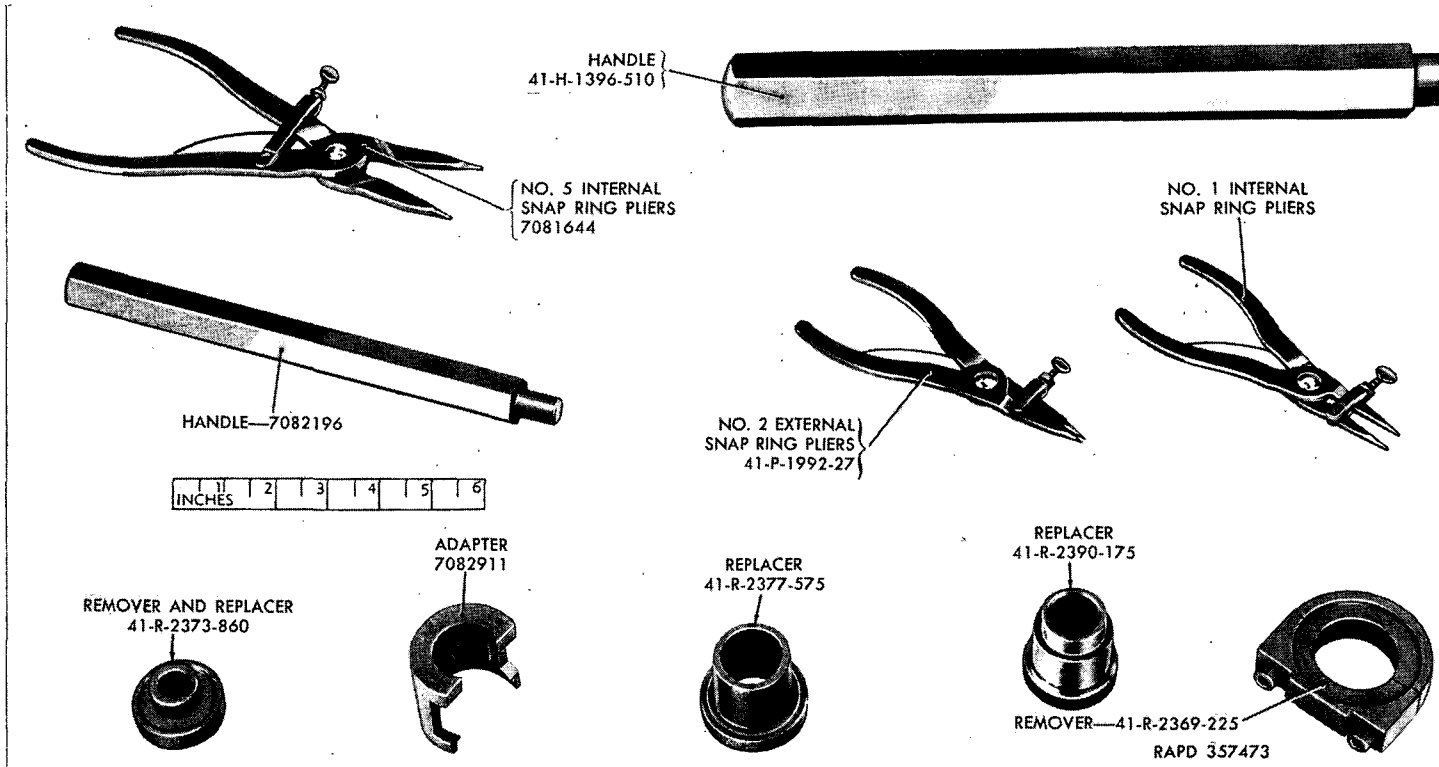


Figure 14. Specially designed tools and equipment.

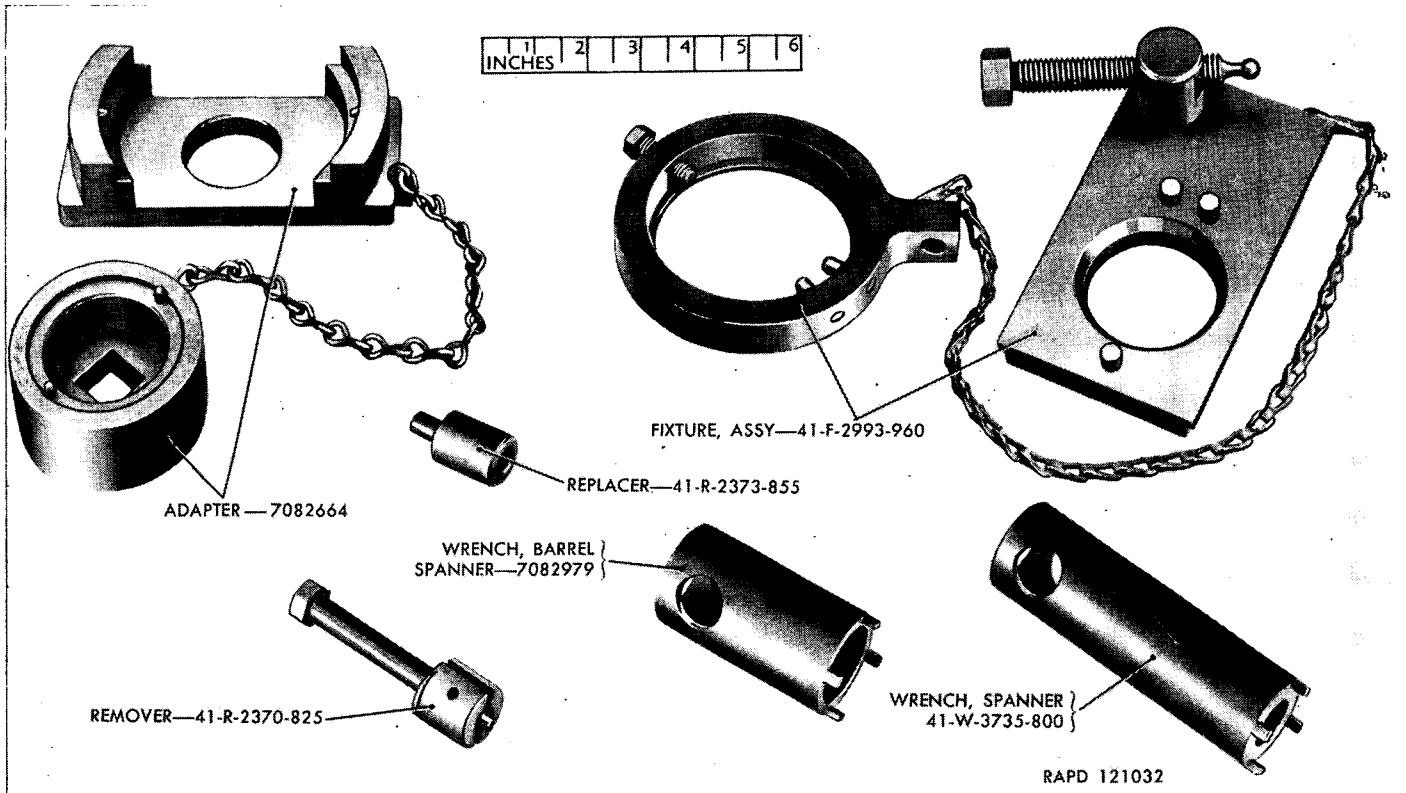


Figure 15. Specially designed tools and equipment.

Table I. Special Tools and Equipment for Field and Depot Maintenance

Item	Identifying number	References		Use
		Fig.	Par.	
ADAPTER, clutch adjusting.	7082664	15, 98	40*d*	Used w/VISE and WRENCH, torque 41–W–3634; torque adjustment.
ADAPTER, clutch spring retainer.	7082911	14, 77	37*h*, 40*d*	Used w/PRESS, VISE, or PULLER 41–P–2905–60; clutch-spring retainer removal.
FIXTURE, lash compensating gear assembly.	41–F–2993–960	15, 89	37*j*, 40*b*	Pinion gear, torsion bar, and last compensating gear assembly and/or disassembly.
HANDLE, clutch gear needle bearing.	41–H–1396–510	14, 78, 97	37*h*, 40*d*	Used w/REPLACER, clutch gear needle bearing 41–R–2377–575; used alone as remover.
HANDLE, differential pinion needle bearing.	7082196	14, 70, 99	37*g* and *k*, 40*e*	Used w/REPLACER, differential pinion needle bearing 41–R–2373–855; used alone as remover.
PLIERS, snap ring, external, removing and replacing, No. 2.	41–P–1992–27	14, 66, 109	37*g* and *j*, 40*e*, 42*d*	Retaining ring removal from differential shafts, grip-lever pin, and torsion bar.
PLIERS, snap ring, external, removing and replacing, No. 4.	7081641		37*h*, 40*d*	Retaining ring removal from clutch-gear shaft.
PLIERS, snap ring, internal, removing and replacing, No. 5.	7081644	14	37*e*, 40*f*	Retaining ring removal from no-back housing.
PLIERS, snap ring, internal, removing and replacing, No. 1.		14	37*l*, 40*f*	Retaining ring removal from no-back lock assembly driving member.

Table I. Special Tools and Equipment for Field and Depot Maintenance—Con.

Item	Identifying number	References		Use
		Fig.	Par.	
REMOVER, last compensating gear needle bearing.	41–R–2370–825	15, 91	37*j*	Used w/PRESS; lash-compensating gear needle bearing removal.
REMOVER, output shaft needle bearing inner race.	41–R–2369–225	14, 90	37*j*	Used w/PRESS; output shaft needle bearing inner race removal.
REMOVER and REPLACER, drive gear bearing.	41–R–2373–860	14, 92	37*k*, 40*a*	Used w/PRESS; drive gear bearing removal and/or replacement.
REPLACER, differential pinion needle bearing.	41–R–2373–855	15, 99	40*e*	Used w/HANDLE; differential pinion needle bearing 7082196 replacement.
REPLACER, clutch gear needle bearing.	41–R–2377–575	14, 97	40*d*	Used w/HANDLE; clutch gear needle bearing 41–H–1396–510 replacement.
REPLACER, lash compensating gear needle bearing.	41–R–2390–175	14, 96	40*b*	Used w/PRESS; lash compensating gear needle bearing replacement.
WRENCH, barrel spanner, shifter control shaft bearing nut.	7082979	15, 104	42*b*	Used w/PINS and SCREWDRIVER; shifter control shaft bearing nut removal and/or replacement.
WRENCH, barrel spanner, drive gear bearing nut.	41–W–3735–800	15, 57	37*d* and *k*. 40*a* and *g*	Used w/STAND or VISE; drive gear bearing nut removal and/or replacement.
WRENCH, torque, indicating, ¾ in. sq.—drive, cap 300 lb.-ft.	41–W–3634	98	40*d*	Used w/VISE and ADAPTER; adjusting clutch 7082664 torque adjustment.

CHAPTER 3
TROUBLE SHOOTING

Section I. GENERAL

9. Purpose

Note. Information in this chapter is for use of ordnance maintenance personnel in conjunction with and as a supplement to the trouble-shooting section in the pertinent operator's manual. It provides the continuation of instructions where a remedy in the operator's manual refers to ordnance maintenance personnel for corrective action.

Operation of a deadlined vehicle without a preliminary examination can cause further damage to the disabled component and possible injury to personnel. By careful inspection and trouble-shooting such damage and injury can be avoided and, in addition, the causes of faulty operation of a vehicle or component often can be determined without extensive disassembly.

10. General Instructions and Procedures

This chapter contains inspection and trouble-shooting procedures to be performed while a disabled component is still mounted in the vehicle and after it has been removed.

a. The trouble-shooting performed while the component is mounted in the vehicle is that which is beyond the normal scope of organizational maintenance. Check the trouble-shooting section of TM 9–718 to be sure the trouble is not a defect normally corrected by using organization, then proceed as outlined in this chapter. These trouble-shooting operations are used to determine if the fault can be remedied without removing the component from the vehicle and, also, when subsequent removal is necessary, to indicate when repair can be made without complete disassembly of the component.

b. Trouble-shooting a disabled component after it has been removed from the vehicle consists of subjecting it to tests on a hydraulic test stand. This chapter discusses those symptoms which can be diagnosed by using the testing equipment and interprets the results in terms of probable causes. Information pertaining to the testing equipment is contained in chapter 5 of this manual.

Section II. TRAVERSING MECHANISM

11. Trouble-Shooting Before Removal

a. GENERAL. If the general inspections recommended in the trouble-shooting of turret traversing system contained in TM 9–718 do not reveal causes of malfunctioning, and the turret is operable, then trouble-shoot it.

b. MANUAL TRAVERSING TROUBLES.

(1) *Manual drive fails to turn turret.*

(*a*) *Outside gun traveling lock is engaged.* Be sure gun traveling lock is disengaged (TM 9–718).

(*b*) *Turret lock is engaged.* Be sure turret lock is disengaged (TM 9–718).

(*c*) *Turret lock pawl is in contact with ring gear.* Adjust turret lock clearance if pawl prevents turret from traversing with lock in unlocked position (TM 9–718).

(*d*) *Output traversing gear and ring gear are stopped by foreign matter.* Inspect for foreign matter and clean, if required.

(*e*) *Traversing motor switch on "ON."* Traversing motor switch must be in "OFF" position when traversing turret manually. Oil from the hydraulic pump disengages hydraulic locking plunger from hydraulic motor driven gear and manual drvie becomes ineffective (TM 9–718).

(*f*) *Hydraulic locking plunger fails to engage hydraulic motor-driven gear.* Spring may be defective or broken. Plunger may be binding in cylinder. Plunger may not be in line with holes in motor-driven gear. Make test as recommended (par. 41).

(*g*) *Clutch spring is defective or broken.* If spring is broken or lacks sufficient force to hold overload clutch against clutch gear, insufficient torque will be transmitted to drive output gear. Install new spring (par. 40).

(*h*) *Keys in hand crank, differential gears, and carrier gear are sheared or missing.* If any of the keys mentioned are omitted in assembly, fall out of place during assembly, or are sheared, the manual drive would fail to turn turret. Disassemble, inspect, and replace (pars. 37, 39, and 40).

(2) *Manual drive fails to traverse freely.*

(*a*) *Output traversing gear and ring gear are impeded by foreign matter.* Inspect for foreign matter and clean, if required.

(*b*) *Improper lubrication.* Lubricate turret race bearings and ring gear in accordance with lubrication order (TM 9–718).

(*c*) *Damaged turret race bearings and ring gear.* If damaged bearings or ring gear prevent traversing turret, replace defective parts.

(*d*) *No-back locking bar tension spring is too strong.* Excessive drag between lock ring and locking bar due to a too heavy or improperly formed locking bar tension spring will require additional torque on manual drive and fatigue gunner. Disassemble, inspect, and replace (pars. 37, 39, and 40).

(*e*) *Dry or defective bearings in traversing gear.* Absence of lubrication on bearings or presence of defective bearings will prevent manual drive from turning freely. Disassemble, inspect, and replace (pars. 37, 39, and 40).

(*f*) *Worn or broken gear or pinion teeth.* Excessive wear on teeth or the presence of broken pieces may impede movement of manual drive. Disassemble, inspect, and replace (pars. 37, 39, and 40).

(3) *Turret fails to stop when manual drive is stopped.*

(*a*) *Key between lock ring and housing is sheared or missing.* This key resists full torque of turret on driven member, locking bar, and lock ring. Disassemble, inspect, and replace (pars. 37, 39, and 40).

(*b*) *Locking bar or driven member is broken.* No-back mechanism becomes inoperative if either of these parts is broken. Disassemble, inspect, and replace (pars. 37, 39, and 40).

(*c*) *Locking bar tension spring is defective or broken.* If spring force is insufficient or spring is broken, locking bar will become inoperative. Disassemble, inspect, and replace spring (pars. 37, 39, and 40).

(*d*) *Locking bar or locking ring is worn.* Excessive wear on these parts will cause locking bar to slip instead of holding turret. Disassemble, inspect, and replace (pars. 37, 39, and 40).

(*e*) *Keys in differential gear and carrier gear are sheared.* If any of these keys are sheared, the turret will coast to a stop or its operation will be erratic. Disassemble, inspect, and replace (pars. 37, 39, and 40).

c. Power Traversing Trouble.

(1) *Hydraulic pump fails to operate.*

(*a*) *Circuit breaker open.* Press traversing electric motor circuit breaker button (TM 9–718).

(*b*) *Battery discharged.* Recharge battery (TM 9–718).

(*c*) *Poor electrical connections.* Check all wiring for shorts and be sure good mechanical and electrical connections are made. Clean and tighten connections or replace wiring (TM 9–718).

(*d*) *Battery overloaded.* Check battery and electrical system (TM 9–718).

(*e*) *Electric motor burned out.* Replace electric motor (TM 9–718).

(*f*) *Electric motor turns but pump does not operate.* Hydraulic pump drive coupling is broken or missing. Carefully disconnect tubing and control joint, and remove hydraulic pump to see if drive coupling is broken, out of place, or missing (par. 21). Insert drive coupling in place, mount pump on motor, and install control joint and tubing (par. 57).

(*g*) *Hydraulic pump gear pump gears or ball bearings broken or frozen.* Disassemble, inspect, assemble, test, and replace (pars. 27, 29, 30, and 57).

(2) *Power drive fails to turn turret.*

(*a*) *Outside gun traveling lock engaged.* Be sure gun traveling lock is disengaged (TM 9–718).

(*b*) *Turret lock engaged.* Be sure turret lock is disengaged (TM 9–718).

(*c*) *Turret lock pawl in contact with ring gear.* Adjust turret lock clearance if pawl prevents turret from traversing with lock in unlocked position (TM 9–718).

(*d*) *Output traversing gear and ring gear stopped by foreign matter.* Inspect for foreign matter and clean, if required.

(*e*) *Electric motor fails to rotate.* Be sure master relay switch is "ON" and traversing motor switch in turret switch box is "ON". Press traversing motor switch circuit breaker button (TM 9–718). If motor still fails to turn, check battery and electric wiring through slip ring box and turret switch box to motor. Repair or replace as required.

(*f*) *Hydraulic pump drive coupling broken or missing.* If electric motor turns and hydraulic pump fails to operate, carefully disconnect tubing and control joint, and remove hydraulic pump to see if drive coupling is broken, missing, or has fallen out of place (par. 21). Insert drive coupling in place, mount pump on motor, and install control joint and tubing (par. 57).

(*g*) *Hydraulic pump gear pump gears or ball bearings broken or frozen.* See *c* (1)(*g*) above.

(*h*) *Hydraulic motor drive shaft or drive gear keys broken or missing.* If these Woodruff keys have fallen out of place, are broken, or missing, hydraulic motor will fail to drive gear traversing mechanism. Carefully disconnect tubing and remove hydraulic motor to see if keys are broken, out of place, or missing (par. 22). Insert keys in place, mount hydraulic motor on motor mount bracket, and install tubing (par. 58).

(*i*) *High-pressure pump relief valve plunger sticking open; spring fatigued or broken.* If plunger does not seat properly and

oil is free to discharge past plunger, or if the plunger spring is fatigued or broken, there will not be sufficient pressure to turn turret. Refit plunger or replace spring (pars. 47, 49, and 50).

(*j*) *Gear pump relief valve plunger sticking open; spring fatigued or broken.* If plunger does not seat properly or if plunger spring is fatigued or broken, there will not be sufficient pressure to actuate locking cylinder plunger nor pump control cam. Refit plunger or replace spring (pars. 47, 49, and 50).

(*k*) *Hydraulic locking plunger fails to withdraw from motor driven gear.* Low gear pump pressure, or binding of hydraulic plunger in driven gear or hydraulic cylinder will prevent power drive from turning turret. Disassemble, inspect, and replace (pars. 37, 39, and 40).

(*l*) *Clutch spring defective or broken.* If spring is broken or lacks sufficient force to hold overload clutch against clutch gear, insufficient torque will be transmitted to drive output gear. Install new spring (par. 40).

(*m*) *Keys in motor driven gear or carrier gear sheared or missing.* If any of these keys are omitted in assembly, fall out of place during assembly, or are sheared, the power drive will fail to turn turret. Disassemble, inspect, and replace (pars. 37, 39, and 40).

(*n*) *Damaged tubing.* Inspect tubing for leaks, dents, or kinks which might decrease the pressure or obstruct the flow of oil. Replace as required (pars. 52, 54, and 55.)

(*o*) *Pistons on control cam sticking.* Foreign matter in control cam piston cylinders, binding of either piston in its cylinder, or improperly installed or binding back-up roller may impede movement of control cam. Move traversing motor switch to "OFF" position. Place an oil pan below pump. Remove small and large control cylinder covers. Press on pistons with thumbs to find out if control cam moves freely through its entire stroke (par. 30*b* and *e*). If necessary, clean and relap, and replace covers (par. 30*h*).

(*p*) *Pilot valve sticking.* Remove equalizer bar cover and gasket and check movement of pilot valve plunger (par. 30*d*). If necessary, clean and relap, and replace gasket and cover (par. 30*d* and *h*).

(*q*) *Pilot valve plunger pin broken or missing.* Remove equalizer bar cover and gasket and check to see if pin is in place (par. 30*d*).

(*r*) *Follow-up pin bent or stuck.* Remove equalizer bar cover and gasket and see if follow-up pin properly actuates equalizer bar when control cam moves from neutral to

full stroke positions. Remove, inspect, and replace, if necessary (par. 30*d*).

(*s*) *Worn or bent control shaft.* Remove equalizer bar cover and gasket, and see if shaft is worn or bent. Remove, inspect, and replace, if necessary (par. 30*e*).

(*t*) *Excessive leakage past flat valve and end of drive shaft.* Disassemble pump (par. 27*b* and *c*), inspect flat valve and end of shaft for score marks, and check to see if equalizer pistons are free. Replace, if necessary (pars. 29*a*(3) and 30*i*).

(*u*) *Damaged or worn hydraulic pump.* Remove and test hydraulic pump (pars. 21 and 64). Rebuild or replace hydraulic pump (pars. 27, 29, 30, and 57).

(*v*) *Damaged or worn hydraulic motor.* Remove and test hydraulic motor (pars. 22 and 64). Rebuild or replace hydraulic motor (pars. 32, 34, 35, and 58).

(*w*) *Low oil level in reservoir.* Check oil level (TM 9–718) and, if necessary, refill as specified in lubrication order.

(3) *Power traversing speed low in either direction.*

(*a*) *Battery charge low.* Check batteries (TM 9–718), and replace or recharge as required.

(*b*) *Poor electrical connections.* Check all wiring to be sure good mechanical and electrical connections are made. Clean and tighten connections.

(*c*) *Damaged tubing.* Inspect tubing for leaks, dents, or kinks which might decrease the pressure or obstruct the flow of oil. Replace as required (pars. 52, 54, and 55.)

(*d*) *Foreign matter in traversing mechanism or turret ring gear.* Inspect for foreign matter that may be lodged in traversing mechanism and turret ring gear. Clean as required.

(*e*) *High-pressure relief valve plunger sticking; spring fatigued or broken.* See *c* (2) (*i*) above.

(*f*) *Hydraulic pump check valves leaking.* Remove and clean check valves (TM 9–718). Replace defective parts or refinish seats (pars. 27, 29, and 30).

(*g*) *Low gear pump pressure.* If gear pump is worn, if relief valve plunger is not seating properly, or if plunger spring is fatigued or broken, there will not be sufficient pressure to operate pump control-cam pistons. Refit plunger or replace spring in oil reservoir (pars. 47, 49, and 50). Disassemble, inspect, assemble, and test pump (pars. 27, 29, 30, and 57).

(*h*) *Pistons on control cam sticking.* (See *c* (2)(*o*) above.

(*i*) *Pistons in hydraulic pump or motor are sticking.* Disassemble, inspect, assemble, and test pump (pars. 27, 29, 30, and 57), and motor (pars. 32, 34, 35, and 58).

(*j*) *Piston holes in hydraulic pump or motor cylinder are worn.* Disassemble, inspect, assemble, and test pump (pars. 27, 29, 30, and 57) and motor (pars. 32, 34, 35, and 58).

(*k*) *Excessive leakage past flat valve and end of drive shaft.* See *c* (2)(*t*) above.

(*l*) *Defective electric motor.* Replace electric motor (TM 9–718).

(*m*) *Worn hydraulic pump.* Disassemble, inspect, assemble, test, and replace hydraulic pump (pars. 27, 29, 30, and 57).

(*n*) *Worn hydraulic motor.* Disassemble, inspect, assemble, test, and replace hydraulic motor (pars. 32, 34, 35, and 58).

(4) *Power traversing speed low in one direction only.*

(*a*) *Either hydraulic pump check valve leaking.* Remove and clean check valves (TM 9–718). Replace defective parts or refinish seats (pars. 27, 29, and 30).

(*b*) *Low gear pump pressure.* See *c*(3)(*g*) above.

(*c*) *Pistons on control cam sticking.* See *c*(2)(*o*) above.

(*d*) *Pilot valve sticking.* See *c* (2)(*p*) above.

(*e*) *Control shaft in pump improperly adjusted.* Check position of control shaft and adjust, if necessary (pars. 30*e* and 57*e*).

(*f*) *Interference in traverse control linkage movement* (fig. 106). Check to see if gunner's shifter control and commander's control handle actuate traverse control linkage sufficiently to move hydraulic pump control lever through the arc shown in figure 119. Eliminate interference, if any.

(*g*) *Gunner's or commander's power traversing control handles* improperly adjusted. Check handle centering springs and adjust, if necessary (pars. 45 and 60).

(*h*) *Sticking slide block back-up piston.* Remove back-up cylinder and inspect back-up plunger (par. 27*h*). Relap plunger, if necessary (par. 29*b* (1)).

(5) *Turret can be power traversed in one direction only.*

(*a*) *Either hydraulic pump check valve leaking.* Remove and clean check valves (TM 9–718). Replace defective parts or refinish seats (pars. 27, 29, and 30).

(*b*) *Sticking pilot valve.* See *c* (2)(*p*) above.

(*c*) *Sticking slide block back-up piston.* See *c*(4)(*h*) above.

(*d*) *Sticking slide block race.* Foreign matter in between rollers and cages, improper installation of shims (if any) below slide block roller plates, or scored surfaces on slide block race may impede slide block movement. Disassemble, inspect, and assemble (pars. 27, 29, 30, and 57).

(*e*) *Foreign matter in gear traversing mechanism or ring gear.* Inspect and clean ring gear, if necessary. Replace gear traversing mechanism, if necessary (pars. 37, 39, and 40).

(6) *Turret creeps in one direction when tank is in a horizontal position.* This normally is caused by the control shaft in hydraulic pump being improperly adjusted. Check position of control shaft and adjust, if necessary (pars. 30*e* and 57*e*).

(7) *Turret creeps excessively when tank is not in a horizontal position.*

Note. When hydraulic pump is operating with gunner's shifter control and commander's control in neutral position and tank is tilted, the unbalanced load of the gun will cause turret to drift slowly until gun reaches the lowest position. If, under similar conditions, the traverse electric motor switch is turned off, the turret may begin to drift rapidly until the gear pump pressure has dropped sufficiently to allow hydraulic locking plunger to enter hydraulic motor drive gear and stop and lock turret from further drifting. Normally, when power or hand traversing is not necessary, engage positive lock to turret ring gear.

(*a*) *Control shaft in hydraulic pump improperly adjusted.* See *c*(6) above.

(*b*) *Either hydraulic pump check valve leaking.* See *c*(5)(*a*) above.

(*c*) *Excessive leakage past flat valve and end of drive shaft.* See *c*(2)(*t*) above.

(*d*) *Piston holes in hydraulic pump or motor cylinder are worn.* See *c*(3)(*j*) above.

(*e*) *Low oil level in reservoir.* Refill to proper level (par. 57*d*) to prevent hydraulic pump from sucking air.

(*f*) *Loose gear pump suction tube connections.* Tighten fittings at port 3 in hydraulic pump and port 13 in oil reservoir (par. 55) to prevent gear pump from sucking air.

(8) *Sluggish or unsteady turret operation.*

(*a*) *Battery low.* Recharge battery (TM 9–718).

(*b*) *Ring gear and output gear bind.* Inspect, repair, or lubricate as necessary.

(*c*) *Poor electrical connections.* See *c*(1)(*c*) above.

(*d*) *Sticking relief valve plungers.* See *c*(2)(*i*) and (*j*) above.

(*e*) *Leaking check valves.* See *c*(3)(*f*) above.

(*f*) *Low oil level in reservoir.* See *c*(7)(*e*) above.

(9) *Abnormal noise in hydraulic pump.*

(*a*) *Low oil level in reservoir.* See *c*(7)(*e*) above.

(*b*) *Loose gear pump suction tube connections.* See *c*(7)(*f*) above.

(*c*) *Worn bearings.* Disassemble, inspect, assemble, test, and replace (pars. 27, 29, 30, and 57).

(*d*) *Sticking radial pistons.* Disassemble, inspect, assemble, test, and replace (pars. 27, 29, 30, and 57).

(e) *Cylinder and shaft piston holes out of alinement.* Replace cylinder shaft and piston assembly (pars. 27, 29, 30, and 57).

(f) *Worn or broken gear pump gears.* Disassemble, inspect, assemble, test, and replace (pars. 27, 29, 30, and 57).

(10) *Abnormal noise in hydraulic motor.*

(a) *Air in system.* See c(9)(a) and (b) above.

(b) *Worn bearings.* Disassemble, inspect, assemble, test, and replace (pars. 32, 34, 35, and 58).

(c) *Sticking radial pistons.* Disassemble, inspect, assemble, test, and replace (pars. 32, 34, 35, and 58).

(d) *Cylinder and shaft piston holes out of alinement.* Replace cylinder, shaft, and piston assembly (pars. 32, 34, 35, and 58).

(11) *Oil leaking from hydraulic pump or hydraulic motor.*

(a) *Shaft oil seal worn.* Remove cover assemblies and replace oil seals (pump: pars. 27*e*, 29, and 30) (motor: pars. 32*d*, 34, and 35).

(b) *Defective gaskets.* Remove and replace leaking gaskets (pump: pars. 27, 29, 30, and 57) (motor: pars. 32, 34, 35, and 58).

(c) *Loose tubing and fitting connections.* Tighten tubing and fittings (par. 55).

(12) *Commander's control inoperative.*

(a) *Circuit breaker open.* Press traversing electric motor circuit breaker button (TM 9–718).

(b) *Defective switch, wiring, connections, or solenoid.* See TM 9–718. Disassemble, inspect, assemble, and test (pars. 42, 44, 45, and 46).

(c) *Obstruction at clutch lever.* Check gunner's shifter control for obstructions to clutch lever movement (pars. 42, 44, and 45).

(13) *Gunner's control inoperative.*

(a) *Clutch lever disengaged.* Check lever movement and remove anything which impedes engagement with control shaft. See paragraphs 42, 44, and 45.

(b) *Closed switch in commander's control.* Check operation of switch in commander's control and solenoid on gunner's shifter control (pars. 42, 44, and 45).

12. Trouble Shooting After Removal and During Operation (on Test Stand)

a. GENERAL.

(1) This paragraph discusses those symptoms which can be diagnosed by operating the hydraulic pump, hydraulic

motor, and oil reservoir on the hydraulic test stand (ch. 5). The inspection and trouble shooting outlined in this paragraph should be performed on all deadlined or rebuilt hydraulic pumps, hydraulic motors, or oil reservoirs.

(2) If test stand is fully equipped with hydraulic pump, hydraulic motor, and oil reservoir, it will be possible to trouble-shoot a deadlined or rebuilt hydraulic pump, hydraulic motor, or oil reservoir of any tank, without removing the entire drive from the tank.

(3) Unless the trouble-shooting in the tank indicates that the hydraulic pump gear pump gears or bearings are broken or frozen, or the hydraulic motor bearings are broken or frozen, it is not necessary to disassemble these components before placing them on the test stand for further trouble-shooting.

(4) During all tests on test stand, be on the alert for any unusual operating noises or overheating. If unusual noise or excessive heat is developed, immediately shut off electric motor drive and investigate trouble.

(5) Before starting the electric motor for any tests on test stand, check to be sure that all tubes and fittings are tightened properly and that there is sufficient oil in reservoir. When tests are made with covers or tubes removed and all drain oil is not returned to oil reservoir, check level in reservoir frequently to be sure it does not drop down too low.

(6) No provision has been made on hydraulic test stand for testing deadlined or rebuilt gear traversing mechanisms. However, manual operation of gear traversing mechanisms can be tested while assembled unit is bolted to assembly stand or while unit is lying on a bench. Power operation of gear traversing mechanisms in either direction, under no load, can be tested while unit is bolted to assembly stand or while unit is lying on a bench, by connecting the fittings on the hydraulic motor and hydraulic locking cylinder to a hydraulic pump and an oil reservoir. If assembly stand is equipped with a prony brake, stub shaft, and gear which meshes with output gear on gear traversing mechanism, it will be possible to test power operation under load in either direction.

b. Preparation for Trouble-Shooting Components on Test Stand. See paragraphs 63 and 64.

c. Hydraulic Pump Trouble.

(1) *Insufficient gear pump pressure.*

(*a*) *Shaft rotation wrong.* Shaft should rotate counterclockwise when facing end of shaft.

(*b*) *Recommended pressure.* Normal gear pump pressure is 75 p. s. i. Read pressure on gage No. 1 (par. 64*c*(7)).

(*c*) *Low input speed.* Check electric motor speed with tachometer (par. 14*c*(1)).

(*d*) *Fatigued or broken gear pump relief valve spring or sticking plunger.* Disassemble, inspect, assemble, and test (pars. 47, 49, 50, and 64*c*(7)).

(*e*) *Broken or missing key.* Disassemble, inspect, assemble, and test (pars. 27, 29, 30, and 57).

(*f*) *Worn gears or housing.* Disassemble, inspect, assemble, and test (pars. 27, 29, 30, and 57).

(2) *Insufficient high pressure.*

(*a*) *Recommended pressure.* Normal high pressure relief valve setting is 1,600 p. s. i. (par. 14*c*(1)). Read pressure on gage No. 2 when pump control lever is moved counterclockwise and on gage No. 3 when pump control lever is moved clockwise (par. 64*c*(6)).

(*b*) *Fatigued or broken high-pressure relief valve spring or sticking plunger.* Disassemble, inspect, assemble, and test (pars 47, 49, 50, and 64*c* (6)).

(*c*) *Check valves leaking.* Remove and clean check valves (TM 9–718). Replace defective parts or refinish seats (pars. 27, 29, and 30).

(*d*) *Excessive slip.* See paragraph 64*c* (5).

(*e*) *Pistol holes in cylinder are worn.* See paragraph 11*c*(3)(*j*).

(*f*) *Excessive slip past flat valve.* See paragraph 11*c*(2)(*t*).

(3) *Sluggish control action.*

(*a*) *Low gear pump pressure.* Check for fatigued or broken gear pump relief valve spring or sticking plunger (pars. 47, 49, and 50) or worn gear pump gears. Disassemble, inspect, and assemble pump (pars. 27, 29, 30, and 57). Make test (par 64*c*(7)).

(*b*) *Binding control cam pistons.* See paragraph 11*c*(2)(*o*).

(*c*) *Sticking pilot valve plunger.* See paragraph 11*c*(2)(*p*).

(*d*) *Binding follow-up pin.* See paragraph 11*c*(2)(*r*).

(*e*) *Sticking slide block race.* See paragraph 11*c*(5)(*d*).

(*f*) *Sticking slide block back-up piston.* See paragraph 11*c* (4)(*h*).

(4) *Insufficient delivery in one direction.*

(*a*) *Low gear pump pressure.* See paragraph 12*c*(1).

(*b*) *Control cam not moving to full strike.* See paragraph 64*c*(1).

(*c*) *Sticking slide block race.* See paragraph 11*c*(5)(*d*).

(*d*) *Sticking slide block back-up piston.* See paragraph 11*c*(4)(*h*).

(5) *Delivers oil when in neutral position.*
(*a*) *Readjust control shaft.* See paragraph 64*c*(2).
(*b*) *Improperly installed back-up roller.* See paragraph 64*c*(1).
(6) *Excessive reduction in delivery when under load.*
(*a*) *Excessive slip.* Make tests described in paragraph 64*c*(5).
(*b*) *Piston holes in cylinder are worn.* See paragraph 11*c*(3)(*j*).
(*c*) *Excessive slip past flat valve.* See paragraph 11*c*(2)(*t*).
(7) *Sucking air in system.*
(*a*) *Loose tube or fitting connection at port 3.* Tighten tube and fitting and inspect for cracks to eliminate air from being sucked into pump (par. 55).
(*b*) *Loose tube or fitting connection at port 13 on oil reservoir.* See (7)(*a*) above.
(*c*) *Cracked gear pump housing.* Disassemble, inspect, replace, and test (pars. 27, 29, 30, and 57).
(8) *Excessive noise.*
(*a*) *Air being drawn into system.* See *c*(7) above.
(*b*) *Worn bearings.* See paragraph 11*c*(9)(*c*).
(*c*) *Sticking radial pistons.* See paragraph 11*c*(9)(*d*).
d. Hydraulic Motor Trouble.
(1) *Insufficient torque.*
(*a*) *Pressure low.* See paragraph 64*c*(6).
(*b*) *Excessive slip.* See paragraph 64*c*(5).
(*c*) *Tight bearings.* See paragraph 11*c*(9)(*c*).
(2) *Insufficient speed.*
(*a*) *Excessive slip.* See paragraph 64*c*(5).
(*b*) *Tight bearings.* See paragraph 11*c*(9)(*c*).
(*c*) *Sticking radial pistons.* See paragraph 11*c*(9)(*d*).
(3) *Excessive noise.*
(*a*) *Air in system.* See paragraph 11*c*(9)(*a*) and (*b*).
(*b*) *Worn bearings.* See paragraph 11*c*(9)(*c*).
c. Sticking radial pistons. See paragraph 11*c*(9)(*d*).
e. Oil Reservoir Trouble.
(1) *High-pressure relief valve defective.*
(*a*) *Spring fatigued or broken.* See paragraph 11*c*(2)(*i*).
(*b*) *Plunger sticking.* See paragraph 11*c*(2)(*i*).
(2) *Gear pump relief valve defective.*
(*a*) *Spring fatigued or broken.* See paragraph 11*c*(2)(*j*).
(*b*) *Plunger sticking.* See paragraph 11*c*(2)(*j*).
(3) *Leaks.*
(*a*) *Inspection cover.* Replace gasket. See paragraphs 47, 49, and 50.
(*b*) *Fittings.* Tighten fittings and check for cracks. See paragraph 55.
(*c*) *Relief valve caps.* Replace copper gaskets. See paragraphs 47, 49, and 50.

CHAPTER 4

HYDRAULIC TURRET TRAVERSING MECHANISM

Section I. DESCRIPTION AND DATA

13. General
(fig. 1)

The hydraulic turret traversing system is comprised of a two-way variable-delivery hydraulic pump, a constant displacement hydraulic motor, a traversing gear mechanism, a gunner's control mechanism, a crew commander's control mechanism, an oil reservoir, and necessary tubing, hose, and fittings. A hand traversing mechanism is mounted on top of the traversing gear mechanism.

14. Two-Way Variable-Delivery Hydraulic Pump
(figs. 2, 16, and 17)

a. DESCRIPTION OF CONSTRUCTION.

(1) *Radial piston pump.* The variable-delivery hydraulic pump consists essentially of a stationary, balanced flat valve (fig. 18); a ported drive shaft with an integral cylinder having 14 closely fitted rolling pistons; a roller bearing; a slide block race, and a hydraulic servo motor control mechanism. As the drive shaft and cylinder rotate on 2 antifriction ball bearings, centrifugal force keeps the beveled surfaces of the 14 rolling pistons against the inner race of the roller bearing at all times. The inner roller bearing race rotates with the cylinder and drive shaft through contact of the 14 rolling pistons. The slide block race moves on two sets of caged rollers between ground surfaces on the slide block race and plates in the pump case, and is actuated accurately to the left or right of the drive shaft axis by a hydraulically operated control cam. Increasing the eccentricity of the slide block race increases the stroke of the rolling pistons and the volume of oil discharged. Reversing the eccentricity of slide block race reverses the direction of oil flow.

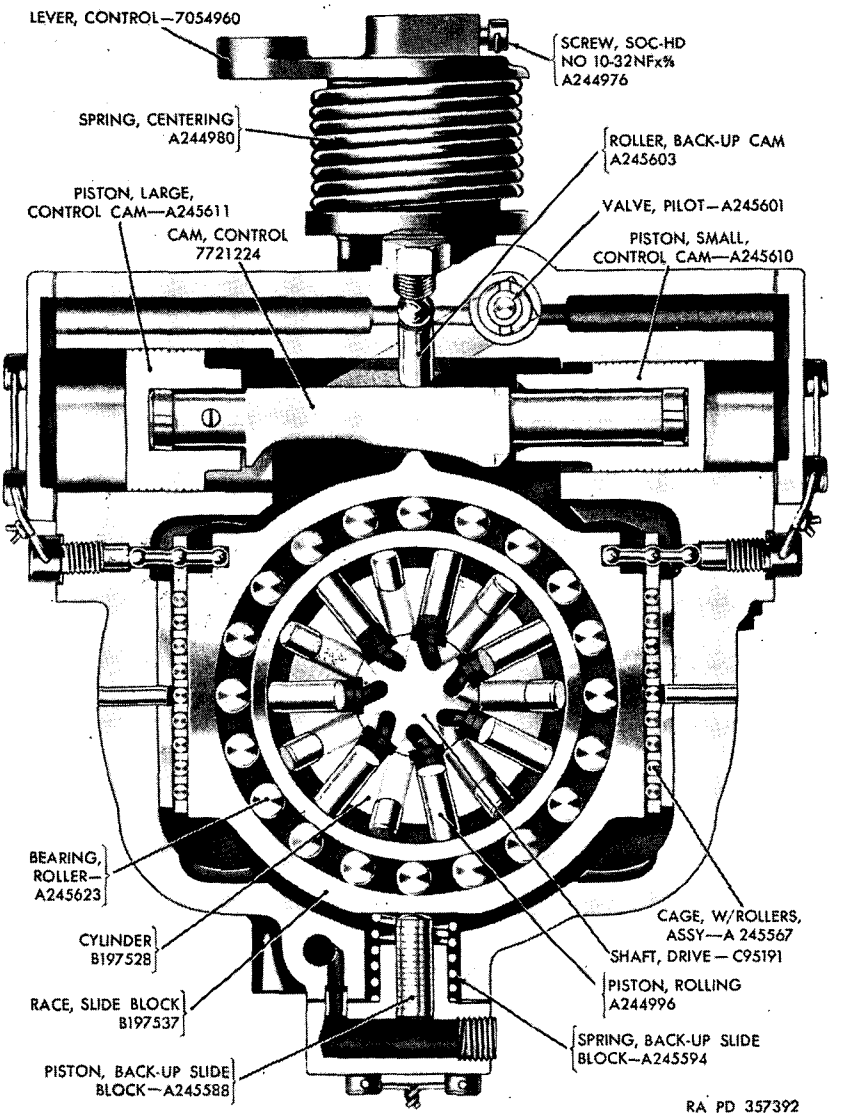


Figure 16. Front elevation cross section of variable-delivery hydraulic pump.

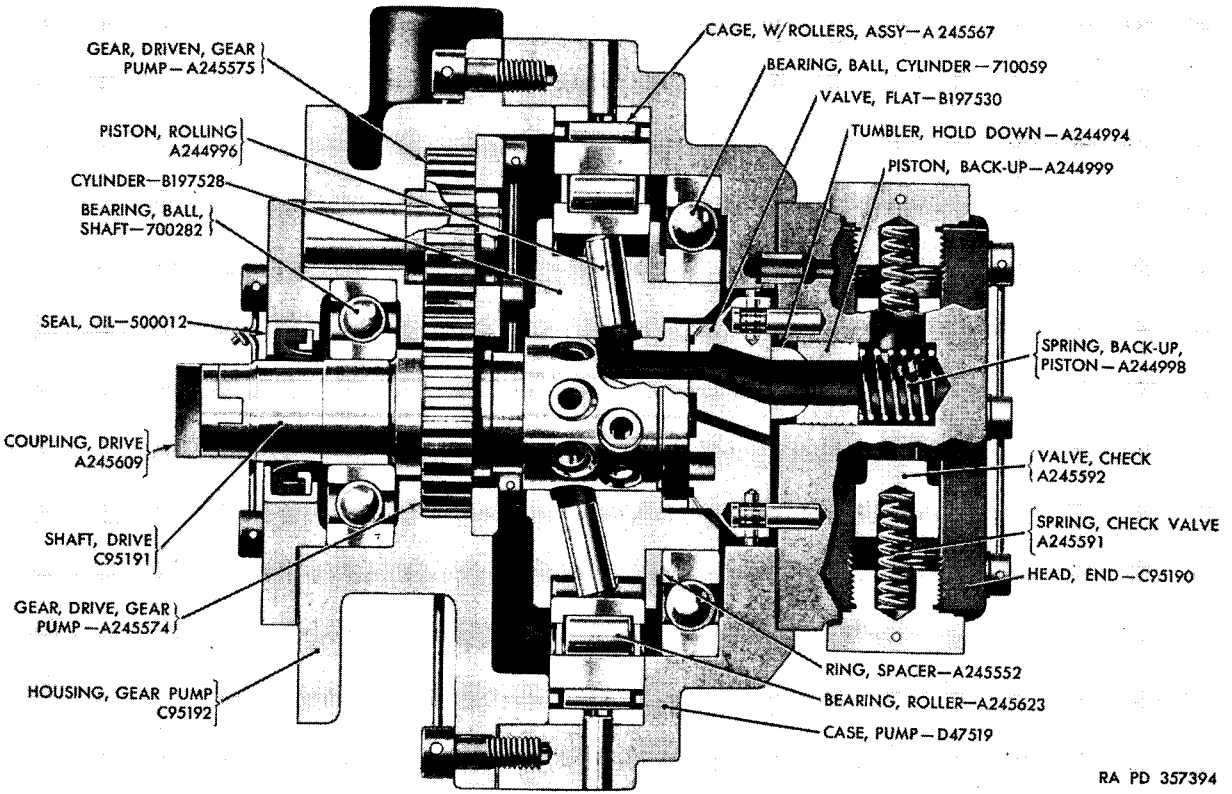


Figure 17. Side elevation cross section of variable-delivery hydraulic pump.

(2) *Pump control.* A spring-centered control lever, eccentric control shaft, equalizing bar, follow-up pin, pilot-valve plunger, control cam, slide block back-up piston, and slide block back-up spring constitute the hydraulic servo motor control (figs. 19 and 20).

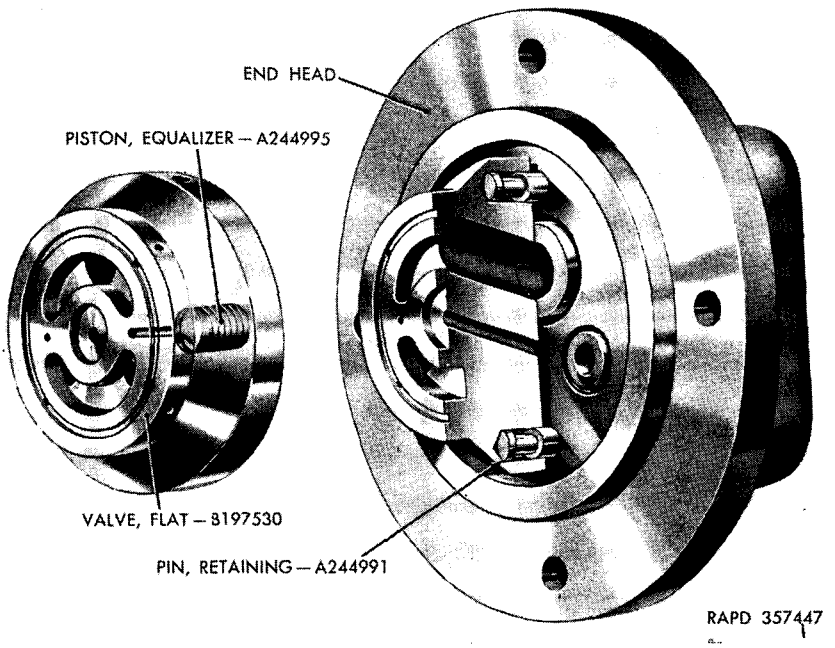


Figure 18. Cross section of hydraulic pump and motor flat valve.

(3) *Pump flat valve.* Back-up piston springs in the pump end head—combined with the hydraulic pressure on the back-up pistons in the end head, and their hold-down tumblers, hold the flat valve against the end of the drive shaft. Two equalizer pistons in the flat valve balance the hydraulic force tending to separate the flat valve from end of drive shaft. Two shoulder pins pressed into the hydraulic pump end head and two locking pins hold flat valve in place for convenience in assembly.

(4) *Gear pump.* Built into the gear pump housing are two gear pump gears, operated by hydraulic pump shaft for supercharging and lubricating the main radial rolling pistons system and for operating the hydraulic servo motor control cam.

(5) *Pump end head.* Two spring-loaded, plunger-type check valves, each consisting of a disk, spring, gasket, and cap, are built into the end head. External pipe taps, stamped

ports 1 and 2, are the high-pressure tubing connections for connecting the hydraulic pump to the hydraulic motor, and the hydraulic pump to high-pressure relief valve in the oil reservoir (figs. 9, 10, and 11).

(6) *Oil passages.* Drilled passages in the gear pump housing, case, and end head connect gear pump discharge to end head check valves, and control cam pistons, and radial piston pump discharge to end head check valves and slide block race back-up piston.

b. Principle of Operation.

(1) *Radial piston pump.* The ported drive shaft with integral cylinder and 14 rolling pistons is driven counterclockwise, when facing end of hydraulic pump shaft, by an electric motor through a coupling. Centrifugal force, combined with the pressure in the hydraulic system, keeps the beveled surfaces of the rolling pistons against the inner race of the roller bearing. Through contact of the rolling pistons, the inner race rotates with the cylinder and the ported drive shaft. The slide block race which moves on two slide block race caged rollers between ground surfaces on the race and plates in the pump case is moved to the right or left of the ported drive shaft axis by a hydraulically operated control cam, slide block back-up piston, and slide block back-up spring. Increasing the eccentricity of the slide block race increases the stroke of the rolling pistons and the volume of oil discharged. Reversing the eccentricity of the slide-block race reverses the direction of oil flow. When the center line of the hydraulic pump drive shaft and slide block race do not coincide, the differences between the radii from the center of the drive shaft to the points of contact of the pistons with the inner race of the roller bearing cause the rolling pistons to move faster or slower than their points of contact with the inner race of the roller bearing. This difference in speed is adjusted by slow, partial rotation of each piston in its cylinder bore—in one direction during the one-half revolution and in the opposite direction during the other half revolution. The pistons thus rotate and reciprocate, simultaneously. Oil flows to and from the rolling pistons through machined passages in the hydraulic pump end head, back-up pistons, hold-down tumblers, flat valve, drive shaft, and cylinder.

(2) *Pump control.* An eccentric control shaft (fig. 20) actuated by the spring-centered control lever depresses or releases the equalizer bar and the spring-loaded pilot valve plunger (fig. 19), to allow oil from the gear pump to actuate the control cam pistons and control cam. See figures 11, 12,

A — CAP, PILOT VALVE — A 245573

B — SPRING, PILOT VALVE — A 245571

C — GASKET, COP — A 245570

D — BUSHING, PILOT VALVE — A 245576

E — PLUNGER, PILOT VALVE — A 245601

F — CASE, PUMP — D 47519

G — CAM, SLIDE BLOCK CONTROL — 7721224

H — PIN, FOLLOW-UP — A 245600

J — PIN, PILOT VALVE PLUNGER — A 245578

K — LEVER, CONTROL EQUALIZER — A 245602

L — SHAFT, CONTROL — 7054964

M — GASKET, COVER — A 245596

N — COVER, EQUALIZER BAR — A 245595

P — SCREW, BAR COVER — A 244976

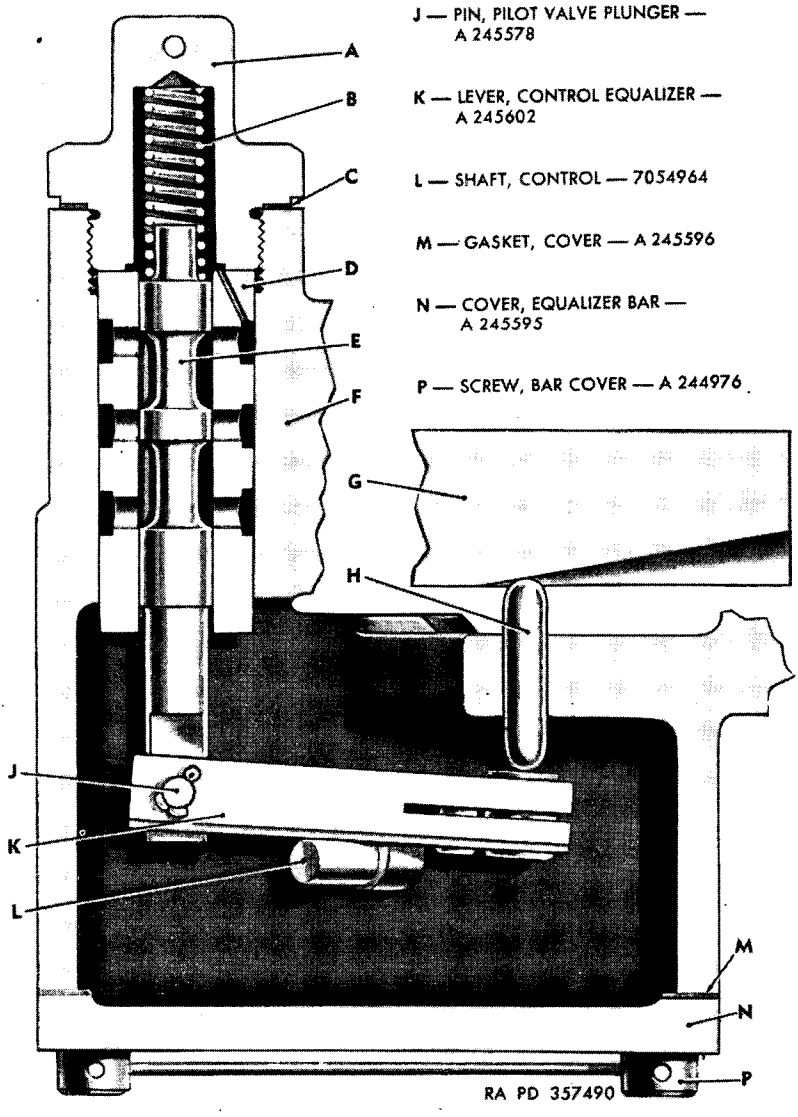
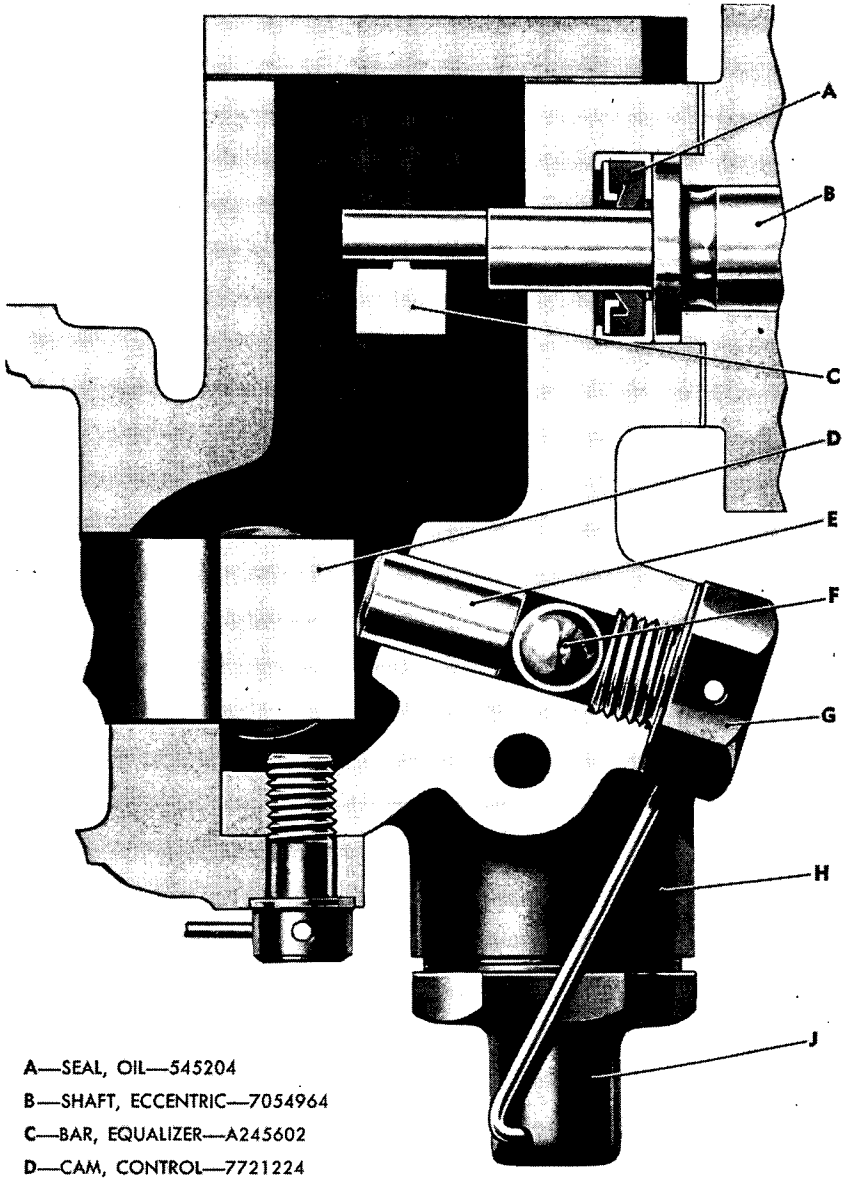


Figure 19. Cross section of hydraulic pump pilot valve plunger, equalizer bar, and follow-up pin.



A—SEAL, OIL—545204
B—SHAFT, ECCENTRIC—7054964
C—BAR, EQUALIZER—A245602
D—CAM, CONTROL—7721224
E—ROLLER, CAM BACK-UP—A245603
F—BALL, CAM BACK-UP—104921
G—SCREW, CAP—A245604
H—CASE, PUMP—D47519
J—CAP, PILOT VALVE SPRING—A245573

RAPD 357448

Figure 20. Cross section of hydraulic pump control cam back-up roller and eccentric control shaft.

and 13 for the flow of oil from gear pump to pilot valve. When the spring-centered control lever is at rest, which is neutral position, as shown in figure 11, oil from the gear pump flows through drilled passages in the case to the small control piston and pilot valve, but cannot actuate the control cam because oil in back of the large control cam piston is blocked by the spring-loaded pilot valve plunger (fig. 19). The flow of gear pump oil to the large control cam piston also is blocked by the pilot valve plunger. When the spring-centered control lever is moved to position "B" (fig. 12), the eccentric control shaft depresses the equalizing lever and the spring-loaded pilot valve plunger, allowing the gear pump oil to flow to the large control cam piston and to move the control cam downward to the position shown in figure 12. As the control cam moves downward, one end of the equalizer bar follows the follow-up pin inward, while the pilot valve plunger spring moves the pilot valve plunger and other end of the equalizer bar outward, until the oil passage leading to the large control cam piston is blocked. When this passage is blocked, movement of the control cam is stopped. Movement of the control cam downward is always proportional to the movement of the spring-centered control lever through arc "A–B." When the spring-centered control lever is moved to position "C" (fig. 13), the eccentric control shaft releases the equalizer bar and the spring-loaded pilot valve plunger, allowing the oil behind the large control cam piston to drain into the pump case and out port 5 to the oil reservoir, while the gear pump oil, acting on the small control cam piston, moves the control cam upward to the position shown in figure 13. As the control cam moves upward, the follow-up pin forces the end of the equalizer bar outward against the eccentric control shaft, acting as a fulcrum, and forces the spring-loaded pilot valve plunger inward until the oil passage from the large control cam piston is blocked. Movement of the control cam upward is always proportional to the movement of the spring-centered control lever through arc "A–C."

(3) *Neutral.* When the center lines of drive shaft and slide block race coincide (fig. 11), no reciprocating motion is imparted to the rolling pistons. Thus, as the shaft and the pumping unit rotate, no oil is delivered.

(4) *Delivery out port 1.* As the inner race of the roller bearing and slide block race are moved to the right by the hydraulically operated control cam and slide block back-up piston (fig. 12), reciprocating motion is so imparted to the rolling pistons that those passing through the arc of the upper crescent passage in flat valve deliver oil to that crescent passage, to the two small hold-down tumblers, and back-up pistons, and oil is discharged out hydraulic pump port 1. Those rolling pistons passing through the arc of the lower crescent passage in the flat valve are sucking or filling up with oil, flowing in hydraulic pump port 2, and through the large back-up piston, hold-down tumbler, and lower crescent. The volume of oil delivered increases proportionately with the increase of eccentricity of the slide block race.

(5) *Delivery out port 2.* As the roller bearing and the slide block race are moved to the left by the hydraulically operated control cam (fig. 13), reciprocating motion is so imparted to the rolling pistons that those passing through the arc of the lower crescent passage in the flat valve deliver oil to that crescent passage, to the large hold-down tumbler, and back-up piston, and oil is discharged out hydraulic pump port 2. Those rolling pistons passing through the arc of the upper crescent passage in the flat valve are sucking or filling up with oil, flowing in hydraulic pump port 1, and through two small back-up pistons, hold-down tumblers, and upper crescent.

(6) *Slide block back-up piston.* Oil pressure from the radial piston pump acting on the slide block back-up piston, combined with the force of the slide block back-up spring keeps the nose of the slide block race against the face of the control cam. A control cam back-up roller supports the back of the control cam.

(7) *Gear pump.* Gear pump gears suck oil from port 13 in the oil reservoir through hydraulic pump port 3, and discharge the oil through drilled passages in the case to the pilot valve for operating the control cam pistons, and through drilled passages to the end head for supercharging and lubricating the radial piston pump through the check valves.

c. DATA.

(1) *General.*

Theoretical displacement per revolution	0.682 cu. in.
Normal input speed	1,750 rpm.
Maximum input speed	2,200 rpm.
High-pressure relief valve setting (normal)	1,600 psi.
Gear pump relief valve setting	75 psi.
Net weight	45 lb.

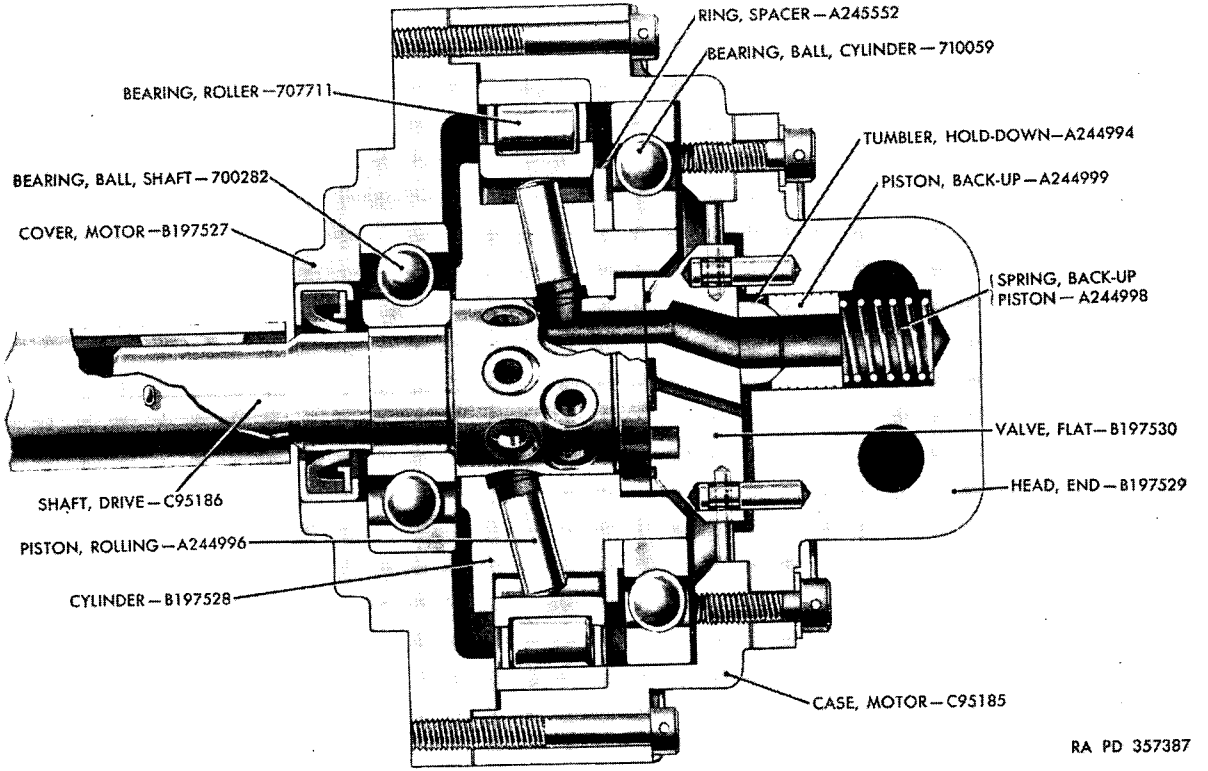


Figure 21. Side elevation cross section of constant displacement hydraulic motor.

(2) *Hydraulic pump port data.*

Port No.	Pipe tap size (in.)	Tube size (in.)	Port description	Port number connected to
1	⅜	½	High-pressure connection.	Motor No. 1. Reservoir No. 11.
2	⅜	½	High-pressure connection.	Motor No. 2. Reservoir No. 10.
3	¼	⅜	Gear pump suction	Reservoir No. 13.
4	¼	⅜	Gear pump pressure	Transverse mechanism hydraulic lock No. 16. Reservoir No. 12.
5	¼	⅜	Case and control drain	Reservoir No. 14.

15. Constant Displacement Hydraulic Motor

(figs. 3, 21, and 22)

a. Description of Construction.

(1) *Radial piston motor.* The constant displacement hydraulic motor consists essentially of a cover, case, and end head (fig. 21), which enclose a balanced flat valve (fig. 18), a ported drive shaft with integral cylinder mounted on two antifriction ball bearings, 14 rolling pistons closely fitted to radial holes in cylinder, and a roller bearing. As fluid power from the hydraulic pump enters the hydraulic motor, the hydraulic motor shaft and cylinder rotate on two antifriction ball bearings. Oil under pressure below the pistons plus centrifugal force keep the beveled surfaces of the pistons against the inner race of the roller bearing. The outer roller bearing race is fitted in the hydraulic motor case at a fixed eccentricity to the center line of drive shaft to provide piston stroke. The inner roller bearing race rotates with the cylinder and drive shaft through contact of the rolling pistons.

(2) *Motor flat valve and end head.* Back-up pistons and springs in the motor end head, combined with the hydraulic pressure on the back-up pistons in the end head and their hold-down tumblers, hold the flat valve against the end of the drive shaft. Two equalizer pistons in the flat valve balance the hydraulic force which tends to separate flat valve from end of drive shaft. The shoulder pins pressed into motor end head and two locking pins hold flat valve in place for convenience in assembly (fig. 18).

b. Principle of Operation.

(1) *Radial piston motor.* Since the center lines of the ported drive shaft and the roller bearing do not coincide, the differences between the radii from the center of drive shaft to the

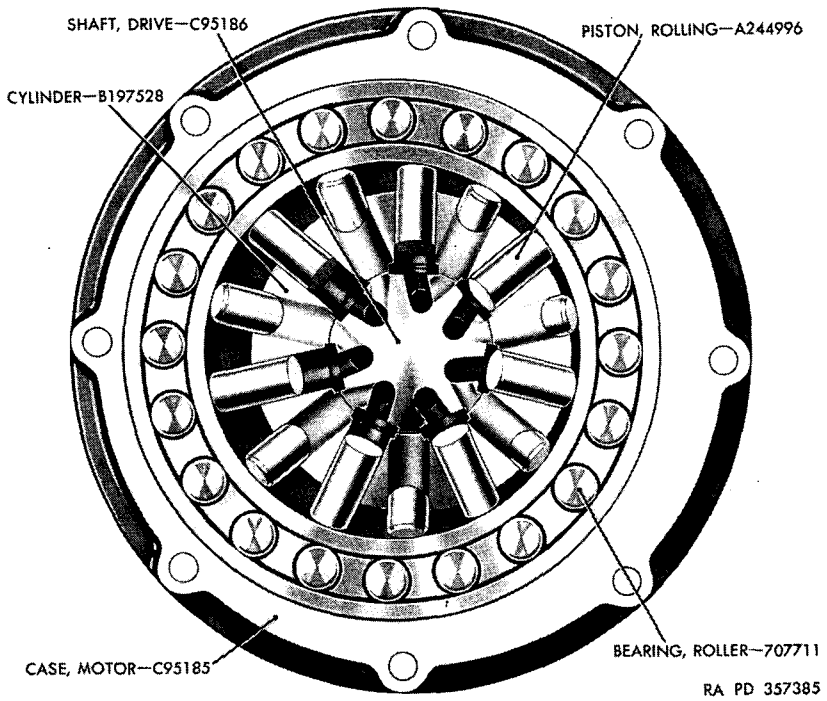


Figure 22. Front elevation cross section of constant displacement hydraulic motor.

points of contact of the rolling pistons with the inner ring of the roller bearing, cause the rolling pistons to move faster or slower than their points of contact with the inner ring of the roller bearing. This difference in speed is adjusted by slow, partial rotation of each rolling piston in its bore—in one direction during one-half revolution and in the opposite direction during the other half revolution of drive shaft. Thus, the rolling pistons rotate and reciprocate, simultaneously. Centrifugal force, plus the pressure in the system, keeps the rolling pistons in contact with the inner race of the roller bearing. Internal slip and leakage lubricates the working parts and then drains out of hydraulic motor port 3 to the oil reservoir.

(2) *Counterclockwise rotation.* Oil delivered from hydraulic pump port 1 to hydraulic motor port 1 (fig. 12) flows through the end head, large back-up piston, hold-down tumbler, upper crescent in flat valve, and those ports in drive shaft connected to upper crescent, to force the rolling pistons passing through the arc of the upper flat valve crescent outward, causing the inner race of the roller bearing, cylinder, and drive shaft to rotate counterclockwise, when facing end of

hydraulic motor drive shaft. Oil discharged by the hydraulic motor rolling pistons, passing through the arc of the lower flat valve crescent, flows through ports in the drive shaft, flat valve, two small hold-down tumblers, two small back-up pistons, and out hydraulic motor port 2, back to hydraulic pump port 2.

(3) *Clockwise rotation.* Oil delivered from the pump port 2 to motor port 2 (fig. 13) flows through the end head, two small back-up pistons, hold-down tumblers, lower crescent in flat valve, and those ports in drive shaft connected to lower crescent, to force the rolling pistons passing through the arc of the lower crescent in flat valve outward, causing the inner race of the roller bearing, cylinder, and drive shaft to rotate clockwise, when facing end of drive shaft. Oil discharged by the rolling pistons passing through the arc of the upper crescent in flat valve flows through the ports in drive shaft, flat valve, large hold-down tumbler, back-up piston, and out hydraulic motor port 1, back to hydraulic pump port 1.

c. DATA.

(1) *General.*

Theoretical displacement per revolution	0.682 cu. in.
Motor output speed at 1,750 rpm pump input speed	1,600 r. p. m.
Motor output speed at 2,200 rpm pump input speed	2,000 r. p. m.
Normal torque at 1,100 psi	90 lb.-in.
Net weight	21 lb.

(2) *Hydraulic motor port data.*

Port No.	Pipe tap size (in.)	Tube size (in.)	Port description	Port number connected to—
1	⅜	½	High-pressure inlet for counterclockwise rotation when facing drive shaft end.	Pump No. 1.
2	⅜	½	High-pressure inlet for clockwise rotation when facing drive shaft end.	Pump No. 2.
3	¼	⅜	Case drain	Traversing mechanism hydraulic lock No. 17 Reservoir No. 15.

16. Traversing Gear Mechanism

(figs. 4, 5, 23, and 24)

a. DESCRIPTION OF CONSTRUCTION.

(1) *Hydraulic drive gear mechanism.* The hydraulic traversing gear mechanism consists essentially of a hydraulic motor, a

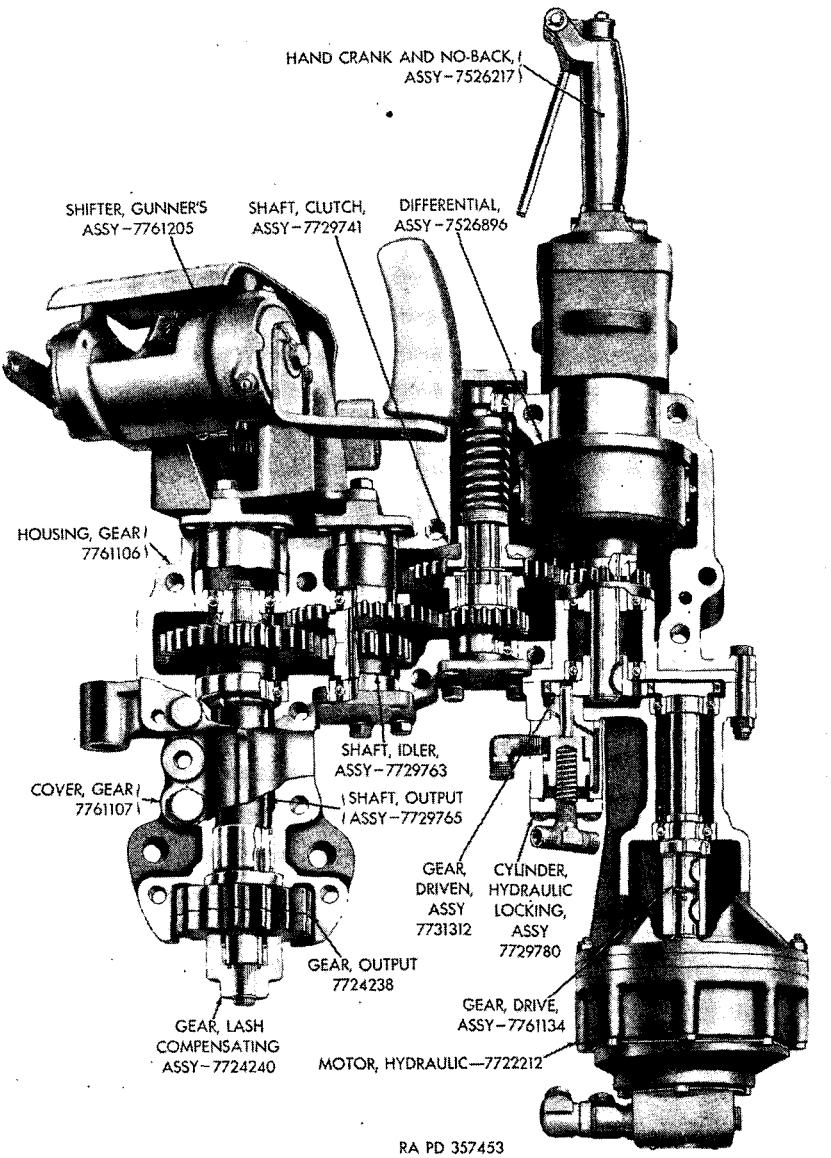


Figure 23. Cross-section of traversing gear mechanism and manual drive.

hydraulic motor drive gear, a hydraulic motor driven gear, two differential pinions, a differential gear, a differential carrier gear, an overload clutch gear, an overload clutch shaft gear, an idler shaft gear, an idler pinion, a pinion shaft gear, and an output gear and torsion bar loaded, lash compensating output gear which mesh with the large stationary internal ring gear fastened to the hull. Gears, shafts, overload clutch, and differential are mounted on closely fitted ball or needle bearings. The entire operating mechanism is fully enclosed in the housing and cover, and the hydraulic motor mount housing. Hydraulic motor is coupled direct to input drive gear shaft. A spring-loaded hydraulic-locking cylinder is mounted on hydraulic motor mount bracket. A spring-loaded, tooth contact type clutch limits hydraulic drive and manual drive against overload. A bevel bear type differential is interposed between hydraulic motor drive and manual drive. A small air breather is screwed to cover. Gunner's shifter control mechanism is mounted on top of traversing gear mechanism.

(2) *Manual drive gear mechanism.* The manual drive gear mechanism is mounted on top of and integral with the hydraulic drive gear mechanism and consists essentially of a spring-loaded grip lever type hand crank, a no-back mechanism, a differential drive gear, two differential pinions, a differential carrier gear, an overload clutch gear, an overload clutch shaft gear, an idler shaft gear, an idler pinion, pinion shaft gear, and an output gear and a torsion bar loaded, lash compensating output gear which mesh with the large stationary internal ring gear fastened to the hull. No-back mechanism connects hand crank bolt to hand crank shaft. All gears, shafts, overload clutch, and differential are mounted on closely fitted ball or needle bearings. The entire operating mechanism is fully enclosed in the housing and cover. A spring-loaded hydraulic-locking cylinder is mounted on hydraulic motor mount bracket. A spring-loaded tooth contact type clutch limits manual drive against overload. A bevel gear type differential is interposed between manual drive and hydraulic drive.

b. Principle of Operation.

(1) *Hydraulic drive gear mechanism.* Power traversing of the turret in either direction is accomplished by the controlled fluid power from the two-way variable-delivery hydraulic pump to the reversible constant displacement hydraulic motor which drives a set of gear trains to an output gear and a lash compensating output gear that mesh with the large stationary internal ring gear fastened to the hull. When

hydraulic pump is started, oil from the gear pump automatically actuates locking cylinder plunger to free hydraulic motor driven gear for power operation. The hydraulic motor is directly coupled to drive gear shaft and traverses the turret through motor drive gear, motor driven gear, differential motor shaft, differential assembly, differential carrier gear, clutch gear, clutch shaft gear, idler shaft gear, idler pinion, pinion shaft gear, output gear, lash compensating output gear, and stationary ring gear. The bevel gear differential is interposed between differental motor shaft and hand crank shaft to permit either power or manual drive with the same gear train. No-back mechanism on hand crank bolt and hand crank shaft prevents turret from coasting or drifting when hydraulic pump control is in neutral position. The spring-loaded tooth contact type clutch limits hydraulic motor drive torque or turret reactionary torque on ring gear and output gear against overload. A torsion bar loaded output gear assembly eliminates lash between output gear teeth and teeth in large stationary internal ring gear fastened to the hull. When hydraulic pump is stopped, the spring-loaded locking cylinder plunger enters motor driven gear to lock power drive.

(2) *Manual drive gear mechanism.* Manual traversing of the turret in either direction is accomplished by rotating the hand crank on top of traversing gear mechanism clockwise or counter-clockwise. Hand crank shaft drives a set of gear trains to an output gear and a lash compensating output gear that mesh with the large stationary internal ring gear fastened to the hull. Hand crank traverses the turret through hand crank shaft, no-back mechanism, differential assembly, differential carrier gear, clutch gear, clutch gear shaft, idler shaft gear, idler pinion, pinion shaft gear, output gear, lash compensating output gear, and stationary ring gear. The bevel gear differential is interposed between hand crank shaft and differential motor shaft to permit either manual or power drive with the same gear train. No-back mechanism on hand crank bolt and hand crank shaft prevents turret from coasting or drifting. The spring-loaded, tooth contact type clutch limits manual drive torque or turret reactionary torque on ring gear and output gear against overload. A torsion bar loaded output gear assembly eliminates lash between output gear teeth and teeth in large stationary internal ring gear fastened to the hull. The spring-loaded locking cylinder plunger enters hydraulic motor driven gear to lock power drive. The spring-loaded

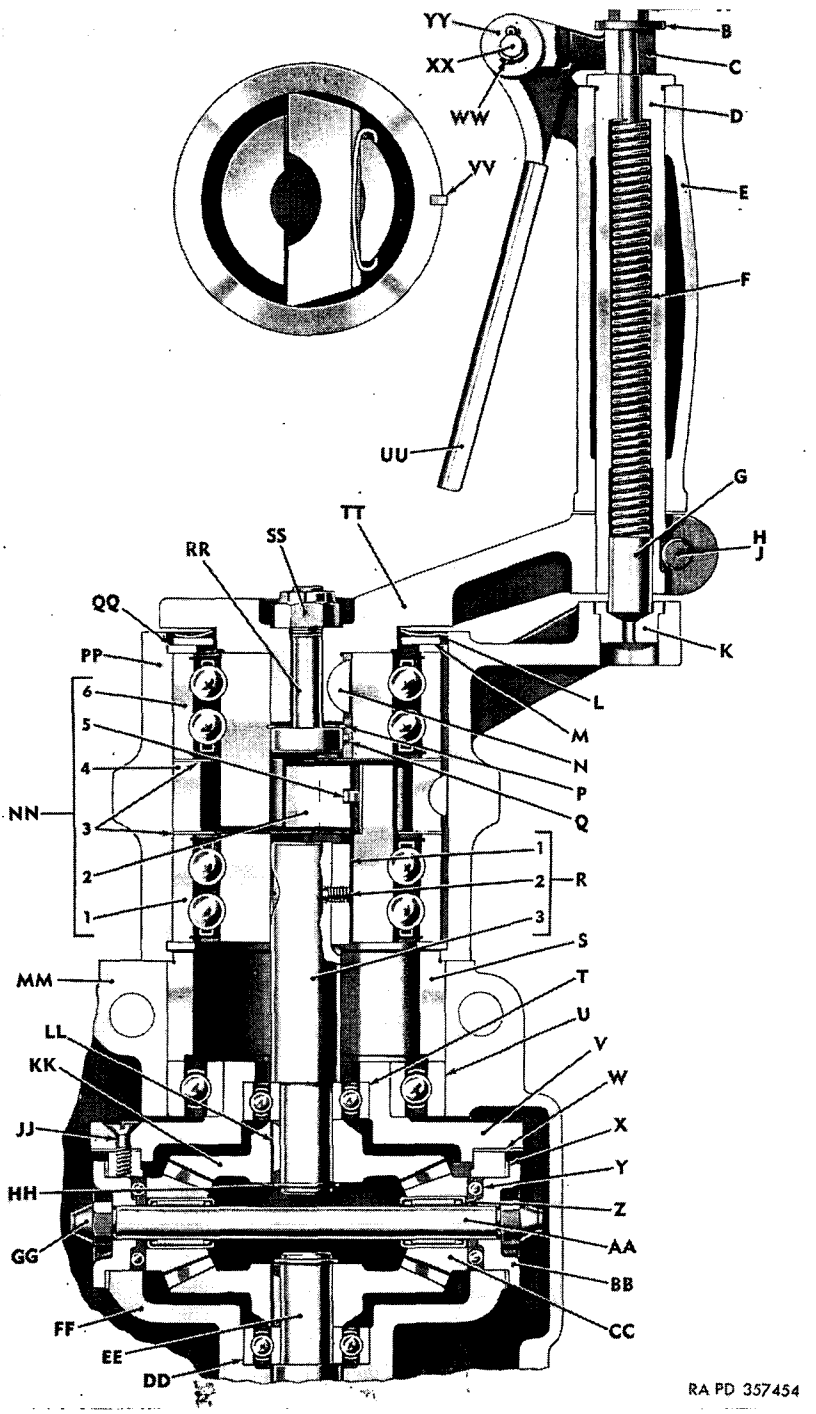


Figure 24. Cross section of manual drive and differential mechanism.

A—NUT, LOCK, NO 10-32NF—503250.
B—WASHER, HANDLE—A213437.
C—COLLAR, HANDLE—A213660.
D—SLEEVE, HANDLE—7751976.
E—HANDLE—7751975.
F—SPRING, SPINDLE—A213415.
G—SPINDLE, HANDLE STOP—7526216.
H—BOLT, HEX-HD, 5/16-24NF X 1¾—223661.
J—NUT, LOCK 5/16-24NF—503345.
K—BUSHING, HANDLE STOP—7752069.
L—DAMPER, SPRING—7526211.
M—WASHER—7526210.
N—KEY, WOODRUFF, 5/32 X 5/8—124546
P—RING, RETAINING—77225546.
Q—PIN, 5/32 X ¼—141126.
R—SHAFT, HAND CRANK, ASSY—7526897.
1—KEY, HAND CRANK SHAFT—7526209.
2—SCREW, MACHINE, FL-HD, NO 8-32NC X ¾—100818.
3—SHAFT, HAND CRANK—7526208.
S—SPACER—7526213.
T—BEARING, HAND CRANK—700061.
U—BEARING, DIFFERENTIAL COVER—701024.
V—COVER, DIFFERENTIAL—7751988.
W—SHIM, COVER (VARIOUS THICKNESSES).
0.002—7752063.
0.005—7752064.
0.007—7752065.
X—SHIM, CAP (VARIOUS THICKNESSES).
0.015—7751991.
0.005—7751992.
0.002—7751993
Y—BEARING, THRUST, PINION—7755208S.
Z—BEARING, PINION—709483.
AA—SHAFT, PINION—7751979.
BB—CAE, THRUST, PINION—7751980.
CC—PINION, DIFFERENTIAL—7751949.
DD—BEARING, MOTOR DRIVEN SHAFT—700061.
EE—SHAFT, MOTOR, DRIVEN—7731306.
FF—CARRIER, DIFFERENTIAL—7729752.
GG—NUT, LOCK, HEX, 5/16-24NF—503345.
HH—RING, RETAINING—7752084.
JJ—SCREW, MACHINE FL-HD, ¼-28NF X ¾—421309.
KK—GEAR, DIFFERENTIAL—7751951.
LL—KEY, WOODRUFF, 5/32 X 5/8—106750.
MM—HOUSING, GEAR—7761106.
NN—LOCK, NO-BACK, ASSY—7526152.
1—DRIVEN MEMBER.
2—LOCKING BAR.
3—SPACER.
4—LOCK RING.
5—LOCKING BAR TENSION SPRING.
6—DRIVING MEMBER.
PP—HOUSING, NO-BACK LOCK—7526215.
QQ—RING, RETAINING—7750326.
RR—BOLT, LOCKING—7526207.
SS—NUT, LOCK, 5/16-24NF—503345.
TT—CRANK, HAND—7526214.
UU—LEVER—7751985.
VV—KEY, WOODRUFF, 1/8 X ½—124543.
WW—PIN, COTTER, 1/16 X 3/8—119981.
XX—PIN, LEVER—A213410.
YY—WASHER, PLAIN, NO 12—147579.

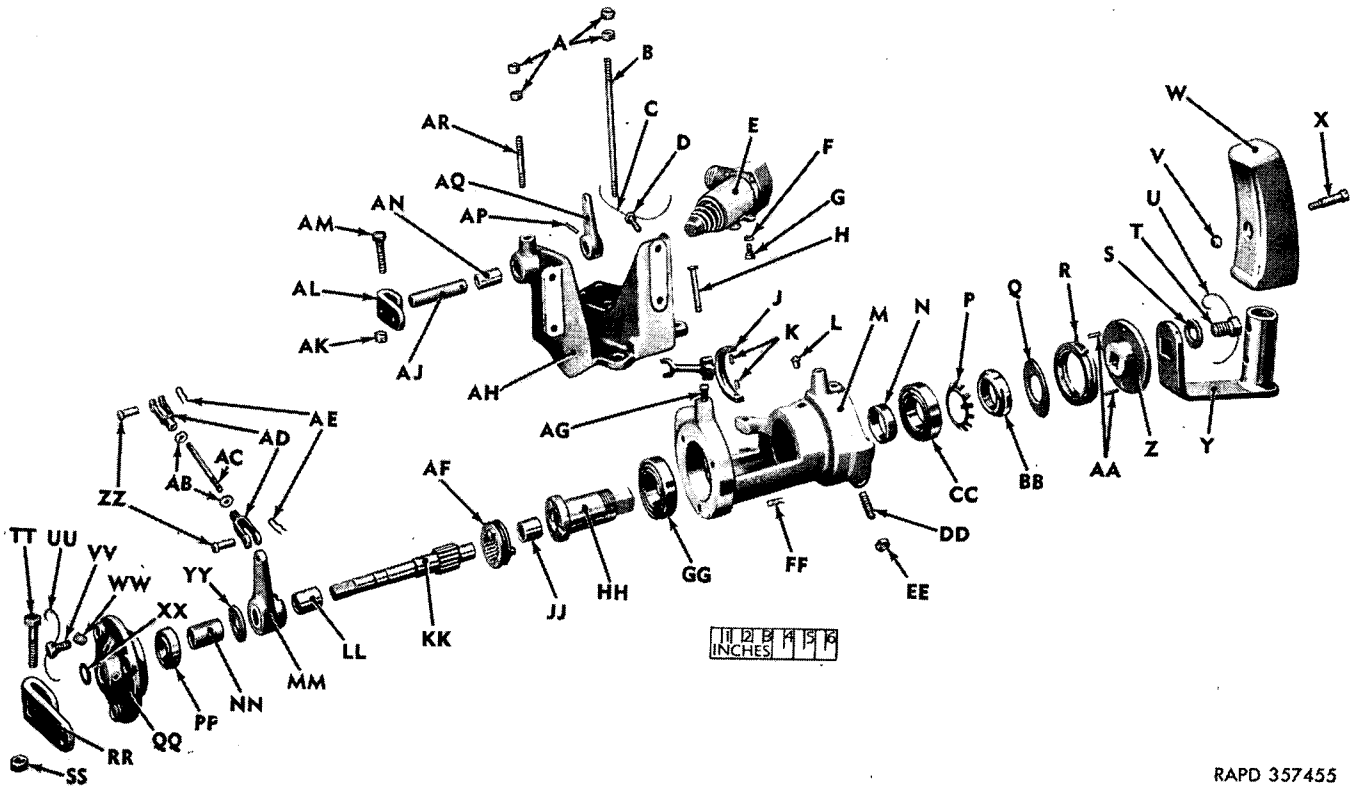


Figure 25. Gunner's shifter control assembly, exploded view.

A—NUT, HEX, ¼-28NF—422890.
B—STUD, COVER SUPPORT—7761198.
C—WIRE, LOCK, 0.041 DIAM—22-W-1642-100.
D—SCREW, CAP, HEX-HD, ¼-20NC X ¾-220621.
E—SOLENOID, CONTROL—7721251.
F—WASHER, LOCK, NO 10—131096.
G—SCREW, MACHINE, FIL-HD, NO 10—32NF X 3/8—100659.
H—PIN, SHIFTER LEVER, ¼ X 1 13/32—544063.
J—LEVER, SOLENOID SHIFTER—7761214.
K PIN, STRAIGHT, 3/16 X 3/8—186837.
L—CUP, OIL, SIZE 0—45-C-9275.
M—BODY, SHIFTER—7761206.
N—SPACER—7761218.
P—WASHER, LOCK, BALL BEARING—711206.
Q—WASHER—7761226.
R—SPRING, CENTERING—7721576.
S—WASHER, PLAIN, 3/8—106263.
T—SCREW, CAP, HEX-HD, 3/8-16NC X ¾—220629.
U—WIRE, LOCK. 0.041 DIAM—22-W-1642-100.
V—NUT, LOCK, NO 10—32NF—503249.
W—HANDLE, SHIFTER CONTROL—7049929.
X SCREW, HANDLE—7049647.
Y—BRACKET, TRAVERSE CONTROL HANDLE, ASSY—7761223
Z—DISC, SPRING CENTERING—7761219.
AA—PIN, STRAIGHT, ⅛ X 9/16—505484.
BB—NUT, LOCK, BALL BEARING—711012.
CC—BEARING, BALL, CONTROL SHAFT—701190.
DD—SCREW, ADJ, SPRING CENTERING—7761221.
EE—NUT, JAM, HEX, ¼-28NF—219706.
FF—CLIP, RETAINING—7719236.
GG—BEARING, BALL, CONTROL SHAFT—701190.
HH—SHAFT, SHIFTER CONTROL—7761216.
JJ—BUSHING, SHAFT—7761245.
KK—SHAFT, SHIFTER—7761209.
LL—BUSHING, LEVER—7761246.
MM—LEVER, CONTROL—7761212.
NN—SPACER, SHIFTER SHAFT—7761211.
PP—BEARING, BALL, SHIFTER CAP—701185.
QQ—CAP, SHIFTER—7761210.
RR—LEVER, CONTROL—7728686.
SS—NUT, LOCK, ¼-20NC—131245.
TT—SCREW, CAP, HEX-HD, ¼-20NC X 1¼—214005.
UU—WIRE, LOCK, 0.041 DIAM—22W-1642-100.
VV—SCREW, CAP, HEX-HD, ¼-20NC X ¾—220621.
WW—CUP, OIL, SIZE 0—45-C-9275.
XX—GASKET, "O" RING, 3/32 X 7/16—546928.
YY—WASHER, THRUST—7761230.
ZZ—PIN, CLEVIS, 3/16 X 3 1/64—121547.
AB—NUT, JAM, HEX, NO 10-32NF—120614.
AC—ROD, CONNECTING—7761224.
AD—YOKE, ROD END, ADJ, NO 10-32NF—Z117824.
AE—CLIP, RETAINING—7754030.
AF—CLUTCH, SHIFTER CONTROL—7721263.
AG—SCREW, MACHINE, RD HD, NO 10-32NF X ½—132908.
AH—BRACKET, SHIFTER—7728523.
AJ—PIN, CRANK—7761225.
AK—NUT, LOCK, ¼-20NC—131245.
AL—LEVER, CONTROL—7328713.
AM—SCREW, CAP, HEX-HD, ¼-20NC X 1¼—214005.
AN—BUSHING, CRANK PIN—7761244.
AP—PIN, STRAIGHT, ⅛ X ⅞—505489.
AQ—LEVER, CRANK—7761259.
AR—STUD, COVER SUPPORT—7761172.

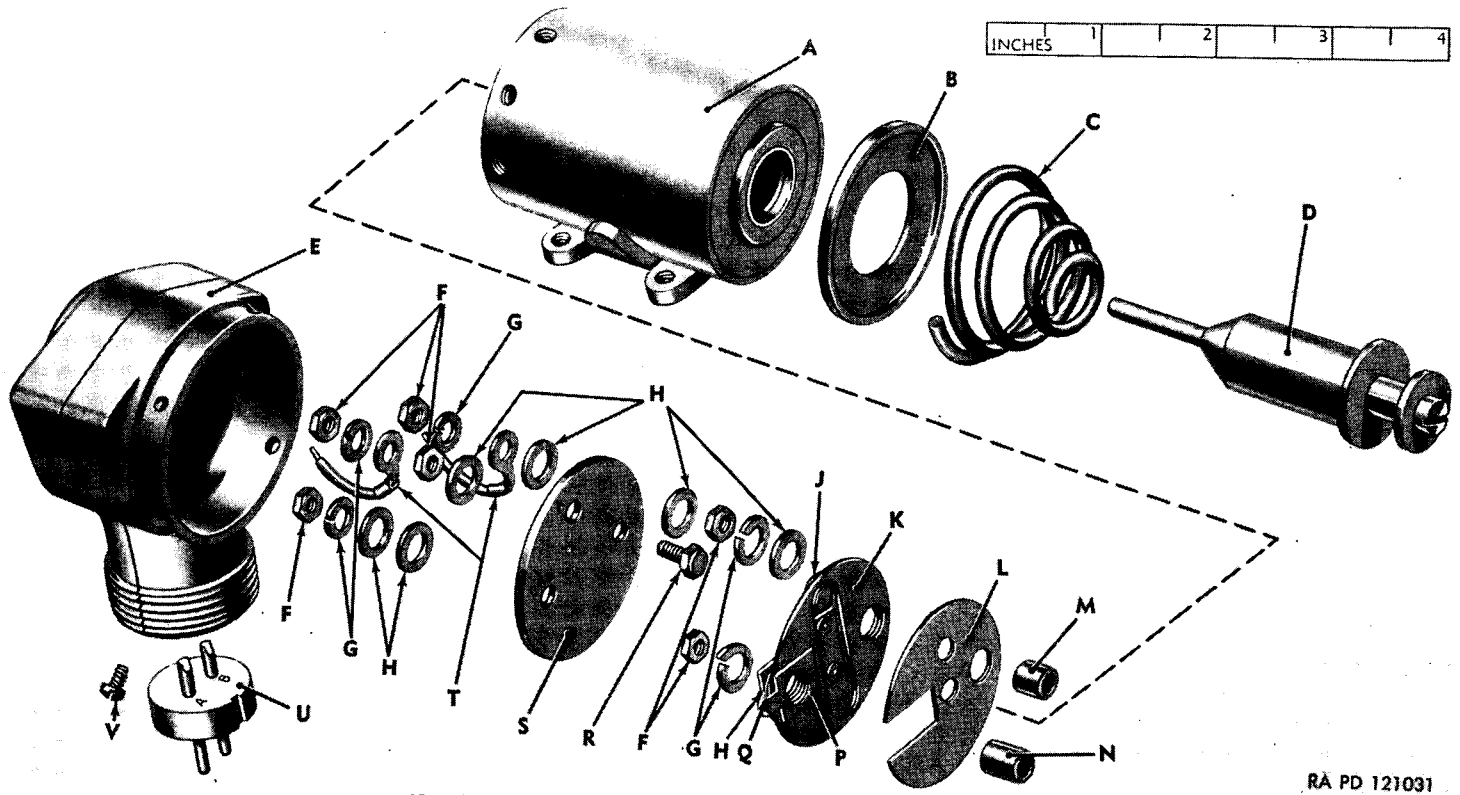


Figure 26. Gunner's shifter control solenoid assembly, exploded view.

A—SOLENOID, ASSY—CED-258-019-00.
B—WASHER, CUP—CED-277-021-00.
C—SPRING—CED-259-014-00.
D—ARMATURE, ASSY—CED-005-008-00.
E—BELL, END—CED-057-198-00.
F—NUT, HEX, NO 6-32NC—CED-CS 9551-ABC6.
G—WASHER, LOCK—AN 935-16.
H—WASHER, FLAT, NO 6—CED-CS 9562-CB3.
J—SPRING, ASSY—CED-260-003-00.
K—INSULATOR—CED-144-022-00.
L—INSULATOR—CED-144-017-01.
M—INSULATOR—CED-144-052-00.
N—INSULATOR—CED-144-013-00.
P—STRAP—CED-256-005-00.
Q—WASHER—CED-277-023-00.
R—SCREW, SILVER CONTACT, NO 4-40 X 5/16—CED-CS 9650-1.
S—INSULATOR—CED-144-021-00.
T—TERMINAL, WIRE—CED-269-002-00.
U—INSERT, ASSY—CED-149-003-00.
V—SCREW, MACHINE, NO 4-40NC X 5/16—CED-CS 9571-3.

grip lever spindle enters cup in cap assembly to keep hand crank close to turret wall when not in use.

c. DATA.

(1) *General.*

Pinion gear	15 teeth.
Pinion shaft gear	34 teeth.
Idler pinion	18 teeth.
Idler shaft gear	42 teeth.
Overload clutch shaft gear	22 teeth.
Overload clutch gear	42 teeth.
Differential carrier gear	22 teeth.
Differential gear	36 teeth.
Differential pinion	15 teeth.
Hydraulic motor driven gear	37 teeth.
Hydraulic motor drive gear	24 teeth.
Hydraulic motor drive gear to pinion gear ratio	21.2:1.
Manual traverse drive gear to pinion gear ratio	13.8:1.
Net weight	150 lbs.

(2) *Traversing mechanism port data.*

Port No.	Pipe tap (size in.)	Tube (size in.)	Port description	Port number connected to
16	¼	⅜	Gear pump pressure	Pump No. 4, reservoir No. 12.
17	¼	⅜	Locking cylinder drain	Motor No. 3, reservoir No. 15.

17. Gunner's and Commander's Power Traverse Controls
(figs. 6, 7, 25, 26, and 27)

a. DESCRIPTION OF CONSTRUCTION.

(1) *Gunner's shifter control.* Mounted on top of traversing gear mechanism and directly in front of the gunner's seat, the gunner's shifter control assembly consists essentially of a handle, a spring-centered handle mounting bracket assembly, a combination shaft assembly mounted on ball bearings, a spring-return pull type solenoid operated clutch, levers, yokes, and rods to actuate control lever on hydraulic pump, and levers, yokes, and rods which connect to commander's control. Solenoid is wired to switch in commander's control.

(2) *Commander's control.* Mounted to ceiling of turret, the commander's control assembly consists essentially of a handle assembly with built-in switch, diaphragm, and spring-loaded grip lever, a mounting housing, a spring-centered shaft mounted on needle bearings, and levers, flexible cable,

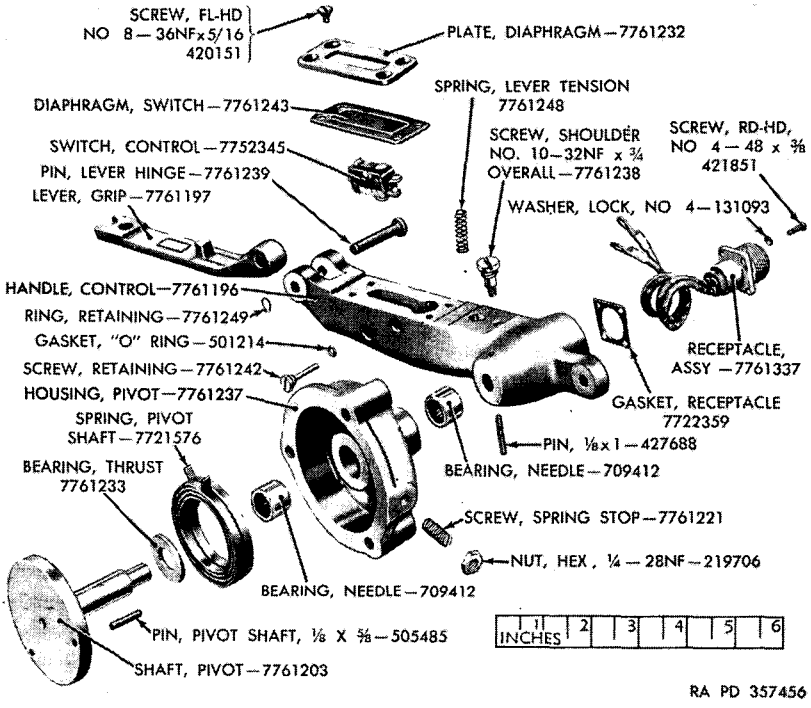


Figure 27. Commander's control assembly, exploded view.

yokes, and rods which connect to gunner's control. Switch is wired to solenoid in gunner's shifter control.

b. PRINCIPLE OF OPERATION.

(1) *Gunner's shifter control.* Turning gunner's shifter control handle either clockwise or counterclockwise controls both the speed and direction of turret traverse. Turning handle turns the spring-centered shaft assembly and moves the levers, yokes, and rods which turn the control lever on hydraulic pump to vary the volume or direction of oil flow to the hydraulic motor. When handle is released, centering spring returns control to neutral position and turret stops. Whenever the grip lever on commander's handle is depressed to actuate switch, solenoid on gunner's shifter control moves clutch on shaft to connect commander's control handle, levers, yokes, and rods directly to hydraulic pump control lever. Gunner's shifter control handle becomes disconnected from shaft, levers, yokes, and rods leading to hydraulic pump control lever.

(2) *Commander's control.* If the commander so desires, he may take over control of turret hydraulic power traversing from the gunner by operating commander's control handle. To

operate commander's control, squeeze the spring-loaded grip level on handle to actuate switch which energizes solenoid in gunner's shifter control to operate clutch which disengages gunner's control shifter handle and engages commander's control handle, flexible cable, levers, yokes, and rods with control lever on hydraulic pump. Turn commander's handle clockwise from neutral to traverse the turret to the right and counterclockwise to traverse turret to the left. The amount the commander's handle is moved away from the spring-loaded neutral position regulates the speed at which the turret traverses. Releasing the commander's grip lever and handle returns the control to neutral and stops the turret. At the same time, solenoid is de-energized and spring moves clutch to disengage commander's control and engage gunner's shifter control to hydraulic pump control lever.

18. Oil Reservoir

(figs 8 and 28)

a. Description of Construction.

(1) *Oil reservoir.* The welded steel rectangular oil reservoir is equipped with three mounting lugs, a breather cap, an oil level gage (dip stick), an oil filler strainer, a handhole cover, a low-pressure gear pump relief valve, a high-pressure variable-delivery pump relief valve, and tube fittings in six ports.

(2) *Relief valves.* Each built-in relief valve consists essentially of a tapered pressed-in seat, a tapered pressed-in bushing, a closely fitted plunger, a compression spring, and cap.

b. Principle of Operation.

(1) *Oil reservoir.* Oil from the reservoir is used as the fluid power medium in the hydraulic turret traversing mechanism system. The oil level can be checked by removing breather cap and gage (dip stick). Oil added to system is poured through the filler strainer nipple on top of reservoir. Handhole cover is removed to clean oil reservoir.

(2) *High-pressure hydraulic pump relief valve.* Overload protection for the radial rolling piston pump, hydraulic motor, and turret traversing mechanism is assured with the high-pressure reverse flow relief valve built into the oil reservoir. Normal setting of relief valve by manufacturer is 1,600 psi. When oil pressure in tube connecting reservoir port 10 exceeds 1,600 psi, the oil discharges past the relief valve plunger, flows out reservoir port 11, and returns to the hydraulic pump. When oil pressure in tube connecting

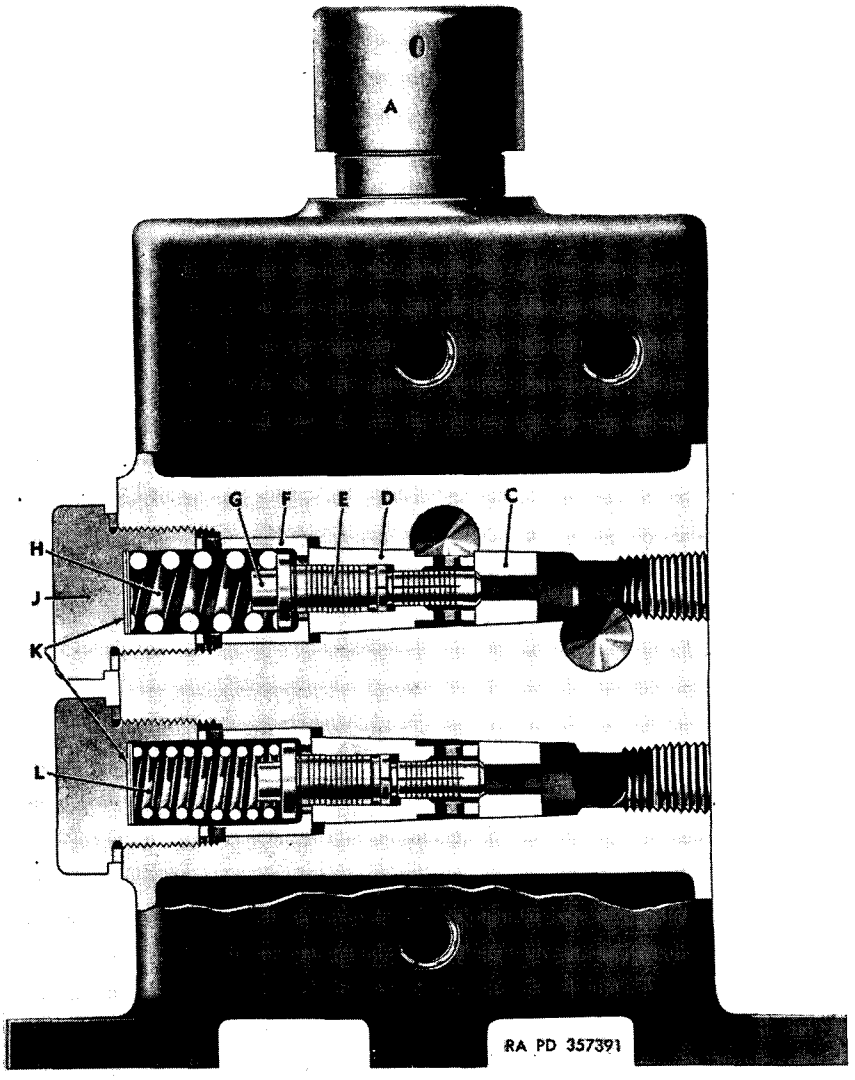


Figure 28. End elevation cross section of oil reservoir and relief valves.

A—CAP, OIL FILLER AND LEVEL INDICATOR—A244958.
B—RESERVOIR, OIL—OG-55074.
C—SEAT, PLUNGER—A244957.
D—BUSHING, PLUNGER—A244956.
E—PLUNGER, RELIEF VALVE—A244953.
F—RETAINER, SPACER—A244951.
G—GUIDE, SPRING—A244952.
H—SPRING, RELIEF VALVE (HIGH PRESSURE)—A244950.
J—CAP, RELIEF VALVE—A244954.
K—SHIM, RELIEF VALVE (VARIOUS THICKNESSES).

0. 005—7069789	0. 031—7069792
0. 010—7069790	0. 062—5244967
0. 020—7069791	0. 093—7069793

L—SPRING, RELIEF VALVE (GEAR PUMP)—A244955.

reservoir port 11 exceeds 1,600 psi, the oil discharges past the relief valve plunger, flows out reservoir port 10, and returns to the hydraulic pump. When oil pressure drops below 1,600 psi, compression spring seals plunger on seat to stop oil flow.

(3) *Low-pressure gear pump relief valve.* Oil delivered by the gear pump for supercharging the variable-displacement hydraulic pump and for actuating the hydraulic pump control cam is limited to a working pressure of 75 psi by a relief valve built into the oil reservoir. Since the gear pump volume is larger than the supercharge and control requirements, adequate pressure is assured at all times. The excess oil is discharged through port 12 and past the low-pressure relief valve into the reservoir.

c. DATA.

(1) *General.*

Capacity ..... 1 gal.
Grade of oil ..... Refer to lubrication order (TM 9–718)
Net weight ..... 18½ lbs.

(2) *Port data.*

Port No.	Pipe tap size (in.)	Tube size (in.)	Port description	Port number connected to—
10	⅜	½	High-pressure relief valve	Pump No. 2.
11	⅜	½	High-pressure relief valve	Pump No. 1.
12	¼	⅜	Gear-pump relief valve	Pump No. 4.
13	¼	⅜	Gear-pump suction	Pump No. 3.
14	¼	⅜	Drain connection	Pump No. 5.
15	¼	⅜	Drain connection	Traversing mechanism hydraulic lock No. 17.

19. Tubing, Hose, and Fittings

(figs. 9, 10, and 29)

a. TUBING. Annealed steel tubing, cut to length and bent to suit installation, is used to connect the hydraulic pump, hydraulic motor, locking cylinder, and oil reservoir and carry the oil to and from these components.

b. HOSE. Assembled hydraulic hose units with male couplings are installed in the two high-pressure tubing lines connecting ports 1 on hydraulic pump and hydraulic motor and ports 2 on the same components.

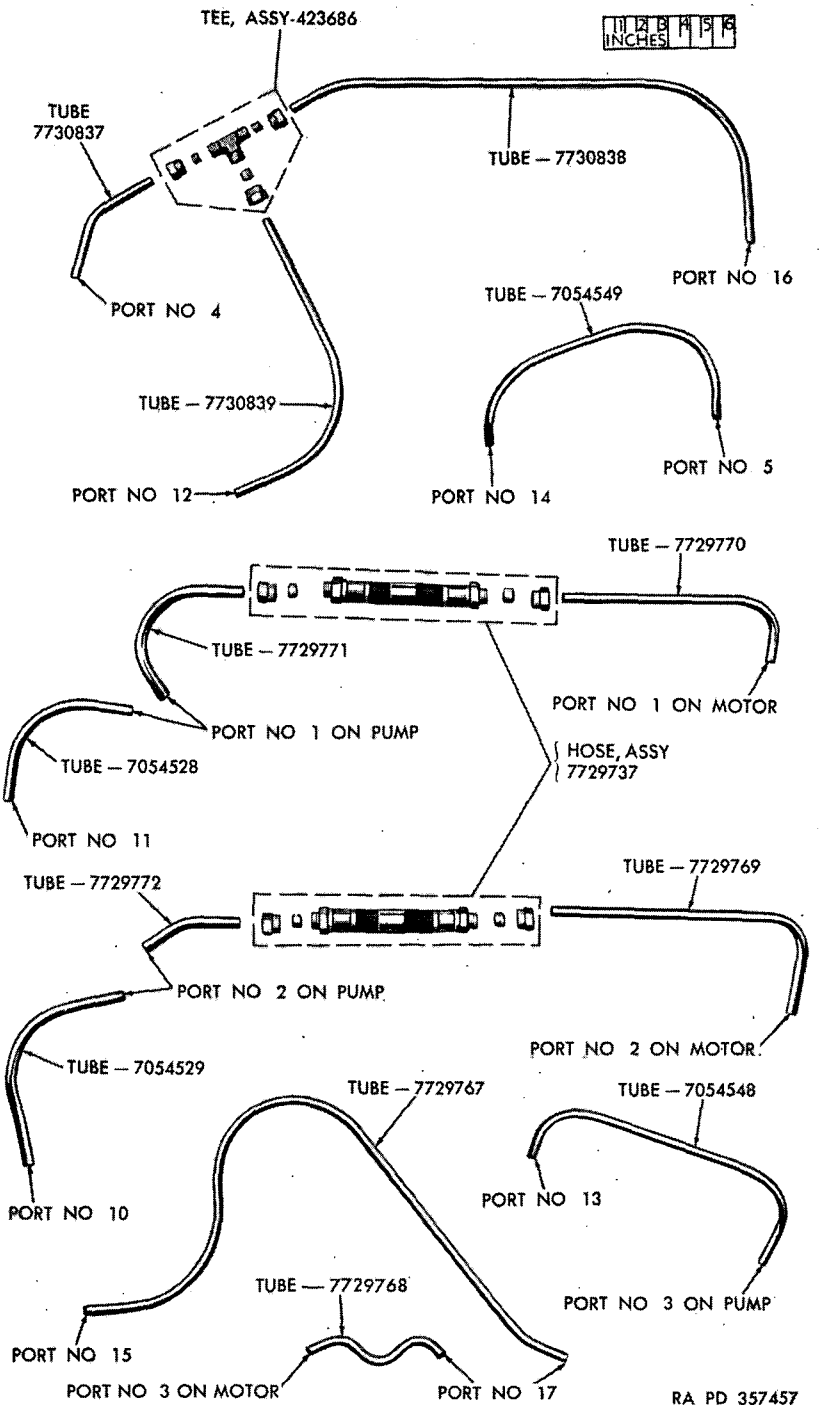


Figure 29. Hydraulic turret traversing tubes, hoses, and fittings.

c. FITTINGS. Flareless, locking shoulder joint connectors, elbows, and tees are furnished as integral parts of hydraulic pump, hydraulic motor, traversing gear mechanism, and oil reservoir.

Section II. DISASSEMBLY OF HYDRAULIC TURRET TRAVERSING MECHANISM INTO SEPARATE COMPONENTS

20. General

a. PREPARATION. It is not necessary to remove turret from vehicle to remove turret traversing mechanism. All operations can be performed while working in turret. Depress barrel of 90-mm gun to its extreme position. Turn traversing motor switch to "OFF" position. Engage turret traversing lock to lock turret in position.

b. SEPARATE COMPONENT REMOVAL. When tests in the turret prove that malfunctioning is caused by one of the components, it is not necessary to remove all of the turret traversing components. Merely remove and replace the defective component. On some occasions it may only be necessary to remove and replace subassemblies of the malfunctioning components to obtain satisfactory operation.

c. TUBE REMOVAL PRECAUTIONS. Before disconnecting any tube, record on a tag, port numbers for both ends of tube, and wire tag to end of tube. Place a clean pan of at least one gallon capacity under component being removed. Wipe off component being removed. Wipe off component before disconnecting any tubes, hoses, or fittings. Always hold fitting with one wrench while applying force on fitting nut with another wrench. Pull tube end and sleeve out of fitting and allow oil to drain into pan. Cover ends of all tubes and hoses removed and all open fittings on units from which tubes have been removed, with cloth or paper to prevent foreign matter from entering traversing system.

Note. Do not plug ends of tubes with cloth or paper. Lint or pulp should not enter system.

21. Removal of Two-Way Variable-Delivery Hydraulic Pump (figs. 2 and 30)

a. GENERAL. Refer to paragraph 20*c*.

b. DRAIN OIL FROM SYSTEM. Disconnect nut on connector fitting in port 13 on end of oil reservoir. Pull tube and sleeve out of fitting and allow oil to drain into pan.

c. REMOVE TUBES AND HOSES. Refer to paragraph 20*c* before proceeding with removal of tubes and hoses. Disconnect nut on connector fitting in oil reservoir port 15 and nut on tee fitting in hydraulic locking cylinder port 17. Remove tube with nuts and sleeves. Dis-

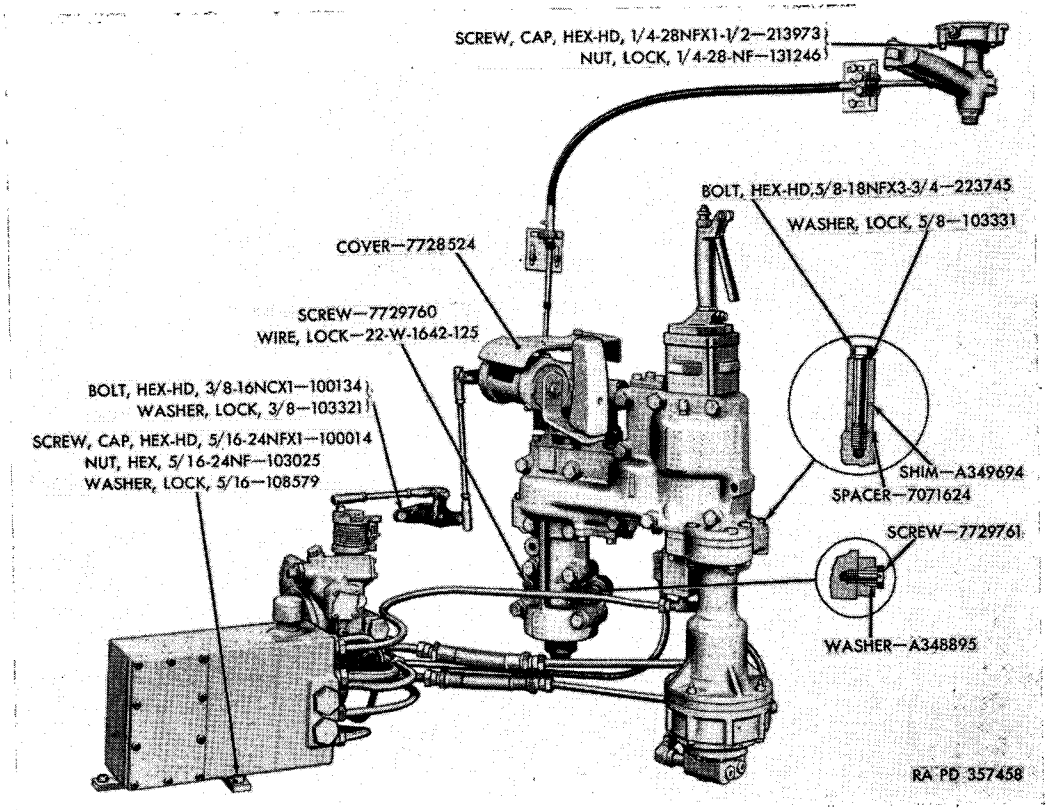


Figure 30. Installation details of hydraulic turret traversing mechanism.

connect nut on connector fitting in oil reservoir port 11 and nut on elbow fitting in hydraulic pump port 1. Remove tube with nuts and sleeves. Disconnect nut on connector fitting in oil reservoir port 10 and nut on elbow fitting in hydraulic pump port 2. Remove tube with nuts and sleeves. Disconnect nut on connector fitting in oil reservoir port 12 and nut on tee fitting leading to hydraulic pump port 4 and hydraulic locking cylinder port 16. Remove tube with nuts and sleeves. Disconnect nut on elbow fitting in hydraulic pump port 1 and nut on elbow fitting in hydraulic motor port 1. Remove tube and hose assembly with nuts and sleeves. Disconnect nut on elbow fitting in hydraulic pump port 2 and nut on elbow fitting in hydraulic motor port 2. Remove tube and hose assembly with nuts and sleeves. Disconnect nut on elbow fitting in hydraulic pump port 4 and nut on elbow fitting in hydraulic locking cylinder port 16. Remove tubes with tee, nuts, and sleeves. Disconnect nut on connector fitting in oil reservoir port 13 and nut on elbow fitting in hydraulic pump port 3. Remove tube with nuts and sleeves. Disconnect nut on connector fitting in oil reservoir port 14 and nut on elbow fitting in hydraulic pump port 5. Remove tube with nuts and sleeves.

d. Remove Control Link. Remove nut on hydraulic pump control lever and disconnect link assembly.

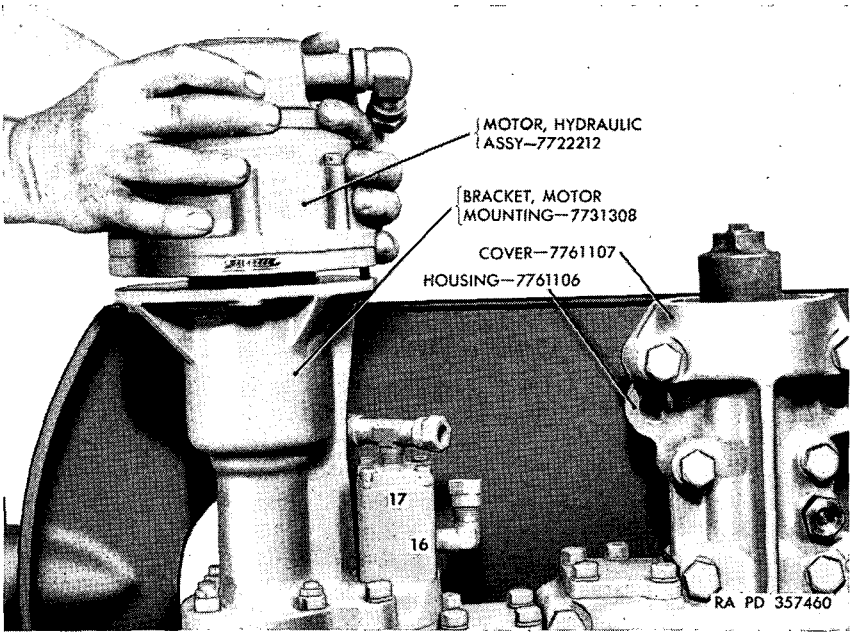


Figure 31. Removing hydraulic motor.

e. Remove Hydraulic Pump. Remove lock wire and four screws which attach hydraulic pump to electric motor. Support hydraulic pump while removing screws. Carefully pull the hydraulic pump off the motor until drive shaft and coupling are clear.

22. Removal of Constant Displacement Hydraulic Motor
(figs. 3, 30, and 31)

a. General. Refer to paragraph 20*c*.

b. Drain Oil From System. Refer to paragraph 21*b*.

c. Remove Tubes and Hoses. Refer to paragraph 20*c* before proceeding with removal of tubes and hoses. Disconnect nut on elbow fitting in hydraulic motor port 1 and nut on elbow fitting in hydraulic pump port 1. Remove tube and hose assembly with nuts and sleeves. Disconnect nut on elbow fitting in hydraulic motor port 2 and nut on elbow fitting in hydraulic pump port 2. Remove tube and hose assembly with nuts and sleeves. Disconnect nut on elbow fitting in hydraulic motor port 3 and nut on tee fitting in hydraulic locking cylinder port 17. Remove tube with nuts and sleeves.

d. Remove Hydraulic Motor. Remove four bolts which attach hydraulic motor to traversing gear mechanism. Carefully pull the hydraulic motor downward off the traversing gear mechanism until coupling on drive shaft is clear.

23. Removal of Turret Traversing Gear Mechanism
(figs. 4, 5, and 30)

a. General. Refer to paragraph 20*c*.

b. Drain Oil From System. Refer to paragraph 21*b*.

c. Remove Tubes and Hoses. Refer to pragraph 20*c* before proceeding with removal of tubes and hoses. Disconnect nut on tee fitting in hydraulic locking cylinder port 17 and nut on connector fitting in oil reservoir port 15. Remove tube with nuts and sleeves. Disconnect nut on elbow fitting in hydraulic motor port 1 and nut on elbow fitting in hydraulic pump port 1. Remove tube and hose assembly with nuts and sleeves. Disconnect nut on elbow fitting in hydraulic motor port 2 and nut on elbow fitting in hydraulic pump port 2. Remove tube and hose assembly with nuts and sleeves. Disconnect nut on elbow fitting in hydraulic locking cylinder port 16 and nut on tee fitting leading to hydraulic pump port 4 and oil reservoir port 12. Remove tube with nuts and sleeves. Disconnect nut on elbow fitting in hydraulic motor port 3 and nut on tee fitting in hydraulic locking cylinder port 17. Remove tube with nuts and sleeves.

d. Remove Control Links and Cable. Remove nut on gunner's shifter control lever and disconnect link assembly leading to bracket. Remove nut on lever connecting commander's control to gunner's

shifter control and disconnect yoke. Unscrew sleeve on solenoid assembly and pull out cable receptacle.

e. Remove Traversing Gear Mechanism. Attach a sling or rope to the traversing mechanism. Remove lock wire and two horizontal mounting screws and washers. Remove two vertical bolts with washers, shims, and spacers. Count shims and note location for installation. Lift mechanism out of turret.

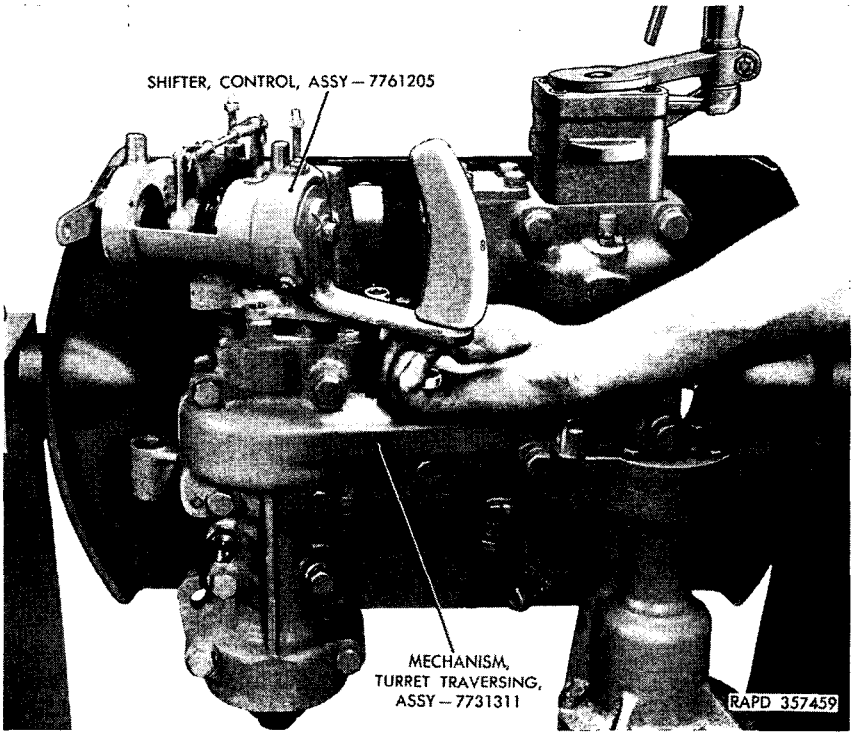


Figure 32. Removing gunner's shifter control assembly.

24. Removal of Gunner's and Commander's Controls
(figs. 6, 7, 30, and 32)

a. Remove Gunner's Shifter Control. Remove nut on gunner's shifter control lever and disconnect link assembly leading to bracket. Remove nut on lever connecting commander's control to gunner's shifter control and disconnect rod end. Unscrew sleeve on solenoid assembly and pull out cable receptacle. Remove locking wire and four screws (fig. 32). Lift off gunner's shifter control assembly.

b. Remove Control Links, Lever Assembly, and Bracket (figs. 30 and 106). Remove nuts connecting assemblies to lever assembly. Remove nut connecting link assembly to hydraulic pump control lever. Remove bolt, lever assembly, spacer, flat washer, and

lock washer from bracket. Remove two bolts and washers holding bracket to turret.

c. Remove Commander's Control. Unscrew sleeve on commander's lever and pull out cable receptacle. Remove nut on commander's control lever and disconnect rod end. Remove three screws and nuts attaching control handle to bracket and remove control handle.

d. Remove Flexible Control and Mounting Plates (fig. 111). Remove nut on commander's control lever and disconnect rod end. Remove nut on lever connecting flexible control to gunner's shifter control and disconnect rod end. Remove four screws, nuts, and washers, two blocks, and flexible control from mounting plates. Remove four screws, eight washers, and mounting plates.

25. Removal of Oil Reservoir
(figs. 8 and 30)

a. General. Refer to paragraph 20*c*.

b. Drain Oil From System. Refer to paragraph 21*b*.

c. Remove Tubes. Refer to paragraph 20*c* before proceeding with removal of tubes. Disconnect nut on connector fitting in oil reservoir port 15 and nut on tee fitting in hydraulic locking cylinder port 17. Remove tube with nuts and sleeves. Disconnect nut on connector fitting in oil reservoir port 11 and nut on elbow fitting in hydraulic pump port 1. Remove tube with nuts and sleeves. Disconnect nut on connector fitting in oil reservoir port 12 and nut on tee fitting leading to hydraulic pump port 4 and hydraulic locking cylinder port 16. Remove tube with nuts and sleeves. Disconnect nut on connector fitting in oil reservoir port 13 and nut on elbow fitting in hydraulic pump port 3. Remove tube with nuts and sleeves. Disconnect nut on connector fitting in oil reservoir port 14 and nut on elbow fitting in hydraulic pump port 5. Remove tube with nuts and sleeves.

d. Remove Oil Reservoir. Support the oil reservoir and remove three screws, nuts, and washers which attach it to mounting bracket. Lift off oil reservoir.

26. Removal of Tubing, Hoses, and Fittings
(figs. 9, 10, 29, and 30)

a. General. Refer to paragraph 20*c*.

b. Drain Oil From System. Refer to paragraph 21*b*.

c. Remove Tubes. Refer to paragraph 20*c*.

d. Remove Hose Assemblies. Disconnect nuts on each end of hose assembly fittings and lift out hose assembly.

e. Remove Fittings. Turn connector, elbow, or tee fitting counterclockwise to remove part from components.

Section III. REBUILD OF TWO-WAY VARIABLE-DELIVERY HYDRAULIC PUMP

27. Disassembly

a. General. Cleanliness is one of the most important factors in the disassembly and inspection of the hydraulic turret traversing mechanism. Make certain the work bench is free from foreign matter. Place a large piece of heavy wrapping paper on the work bench to further insure cleanliness. This precaution will protect the highly finished working surfaces and reduce chances of losing small parts. During disassembly, avoid striking the highly finished surfaces together. After disassembly, and before inspection, wash all hydraulic pump, hydraulic motor, and reservoir parts thoroughly in dry-cleaning solvent or volatile mineral spirits paint thinner and blow them off with compressed air. Bearings, pistons, and other parts having sliding fits or close running surfaces should be coated with hydraulic oil before assembly. Cleanliness, plus care in handling of working parts, will reduce malfunctioning and increase the life of the hydraulic turret traversing mechanism.

b. Remove End-Head Assembly. Cut and remove lock wire from three mounting screws and two check valve caps. Remove end-head mounting screws. Pry end head off connector in case, being careful not to damage connector.

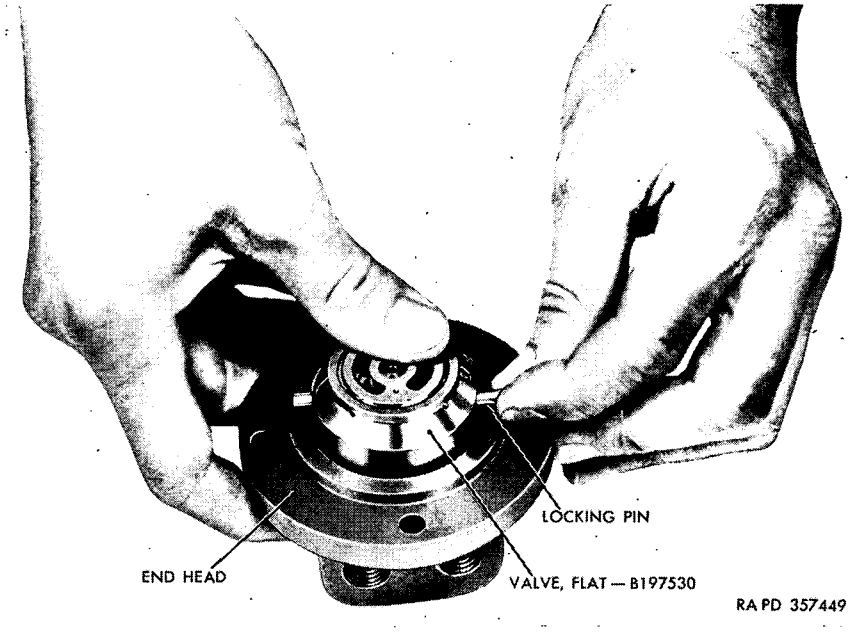


Figure 33. Removing or installing flat valve.

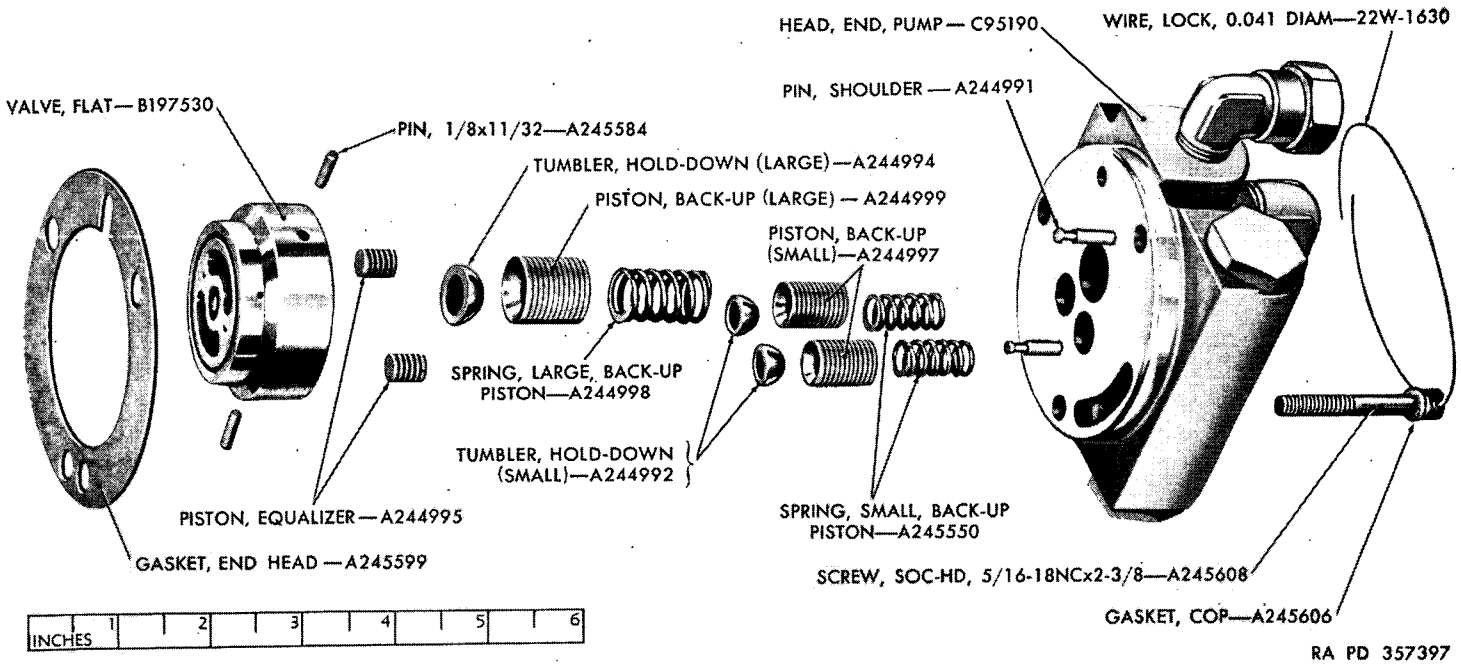


Figure 34. Hydraulic pump end head, exploded view.

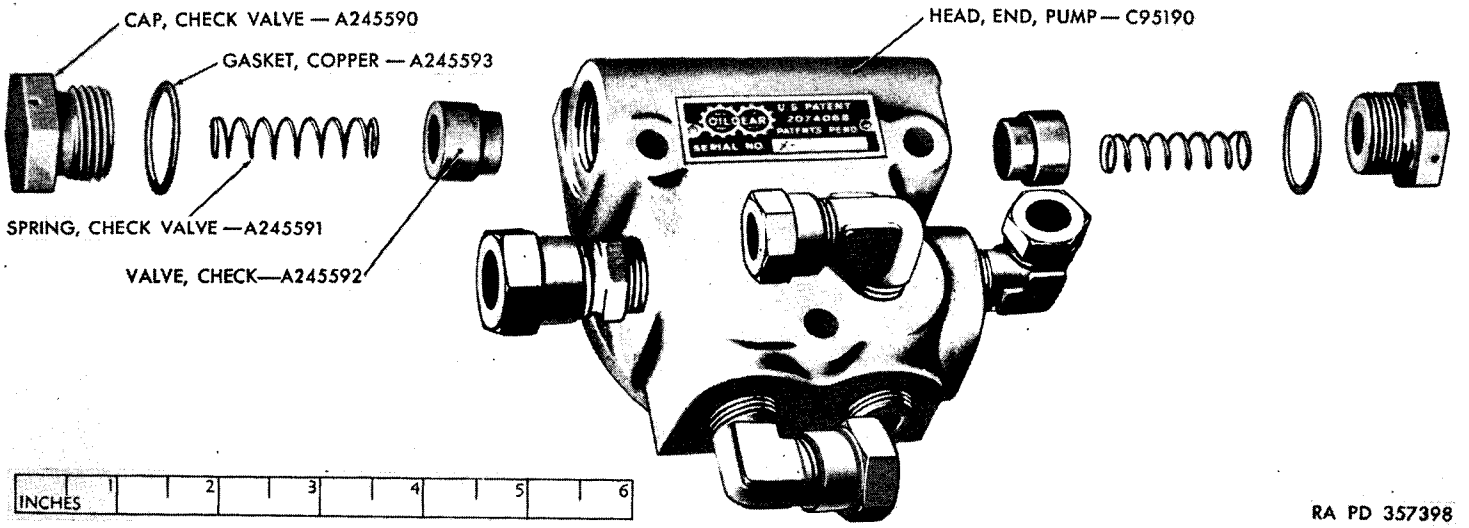


Figure 35. Hydraulic pump check valves in end-head assembly.

c. DISASSEMBLE END-HEAD ASSEMBLY (figs. 33, 34, and 35). Lay nameplate surface of end head on two small blocks to straddle elbow fitting. Depress flat-valve lightly with thumb and pull out the two locking pins (fig. 33). Lift off flat valve and hold-down tumblers. Lift out back-up pistons and back-up springs. Lift out two equalizer pistons from flat valve. If necessary, insert a No. 8–32 screw to remove equalizer pistons.

Note. Mark small back-up pistons and equalizer pistons so as to facilitate assembly in their respective holes.

Two retaining pins are pressed into end head. Do not remove these pins unless replacement is necessary. Remove the two hexagon check valve caps. Do not loosen or remove tube fittings unless replacement is necessary.

d. REMOVE GEAR PUMP HOUSING AND DRIVE SHAFT ASSEMBLY (figs. 36 and 37). Cut and remove wire from the two control cam piston cover screws (fig. 46). Remove the four screws from each control cam piston cover. Check to see if control cam pistons are equal distances from ends of bore. If not, apply finger pressure to either piston to center cam. This procedure moves slide block race to neutral position concentric with drive shaft to permit disassembly

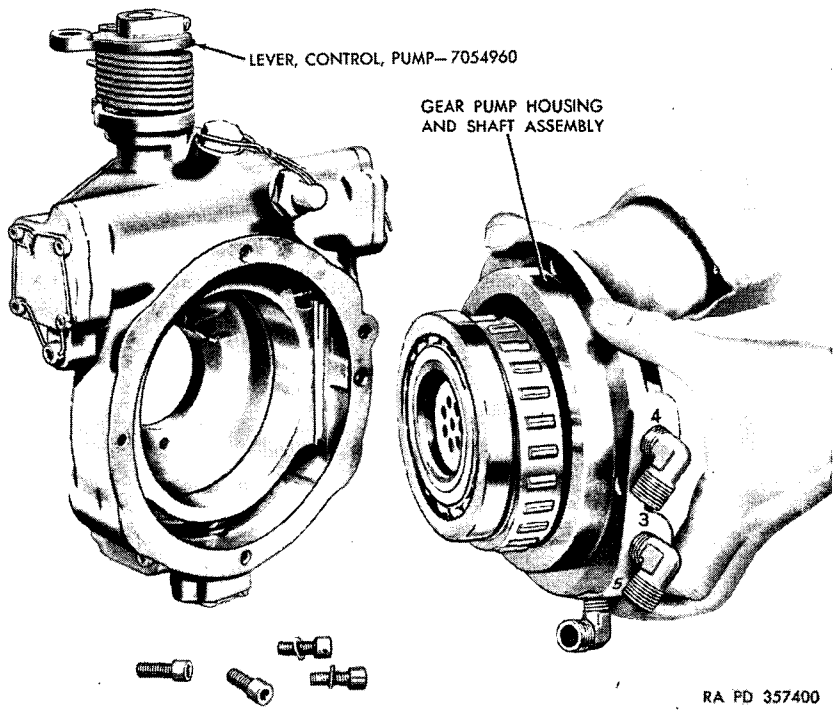


Figure 36. Removing hydraulic pump shaft and gear pump.

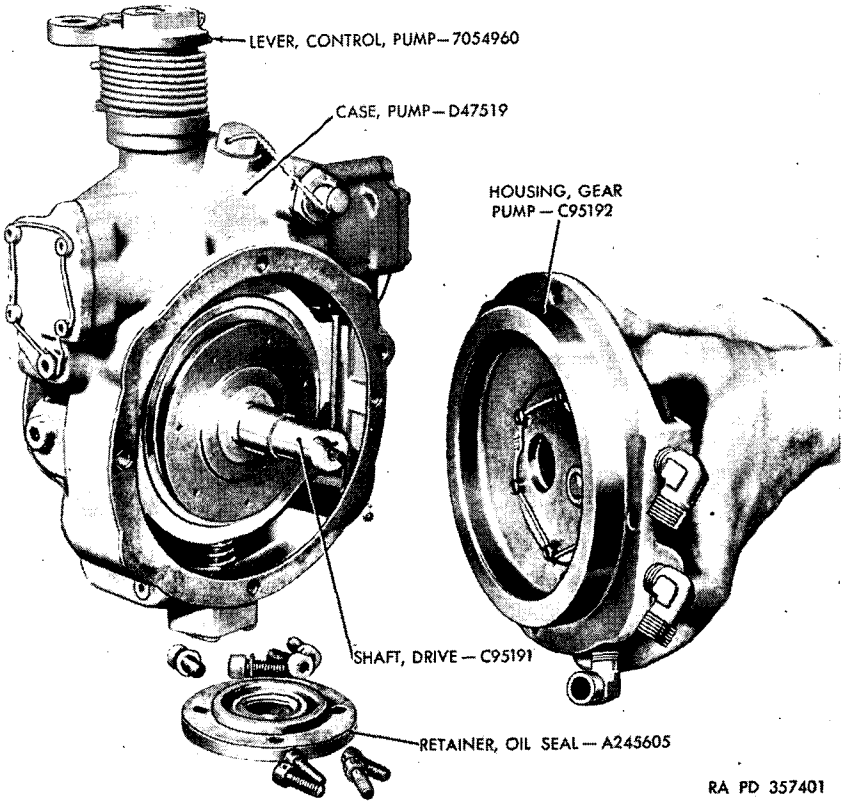


Figure 37. Hydraulic pump gear pump removal.

of gear pump housing and drive shaft assembly. Cut and remove lock wire from the four gear pump housing mounting screws. Remove four gear pump housing mounting screws. Lift off gear pump housing assembly, together with shaft front ball bearing, drive shaft, cylinder, rolling pistons, roller bearing, and rear ball bearing (fig. 36). If unit sticks in case, tap ported end of drive shaft with a brass bar. Place inside face of gear pump housing on two supports and tap coupling end of drive shaft lightly to remove shaft, cylinder, pistons, roller bearing, spacer ring, and rear ball bearing assembly from gear pump housing assembly. As an alternative, the gear pump housing can be removed without disturbing the drive shaft and cylinder assembly (fig. 37), as follows: Remove oil seal housing lock wire. Remove four mounting screws. Lift off oil seal retainer.

CAUTION: Be sure sharp edges on shaft do not cut oil seal. Remove lock wire and four gear pump housing mounting screws. Lay pump on bench and apply a small wheel puller to the coupling end of the drive shaft and gear pump housing flange. Apply jack-

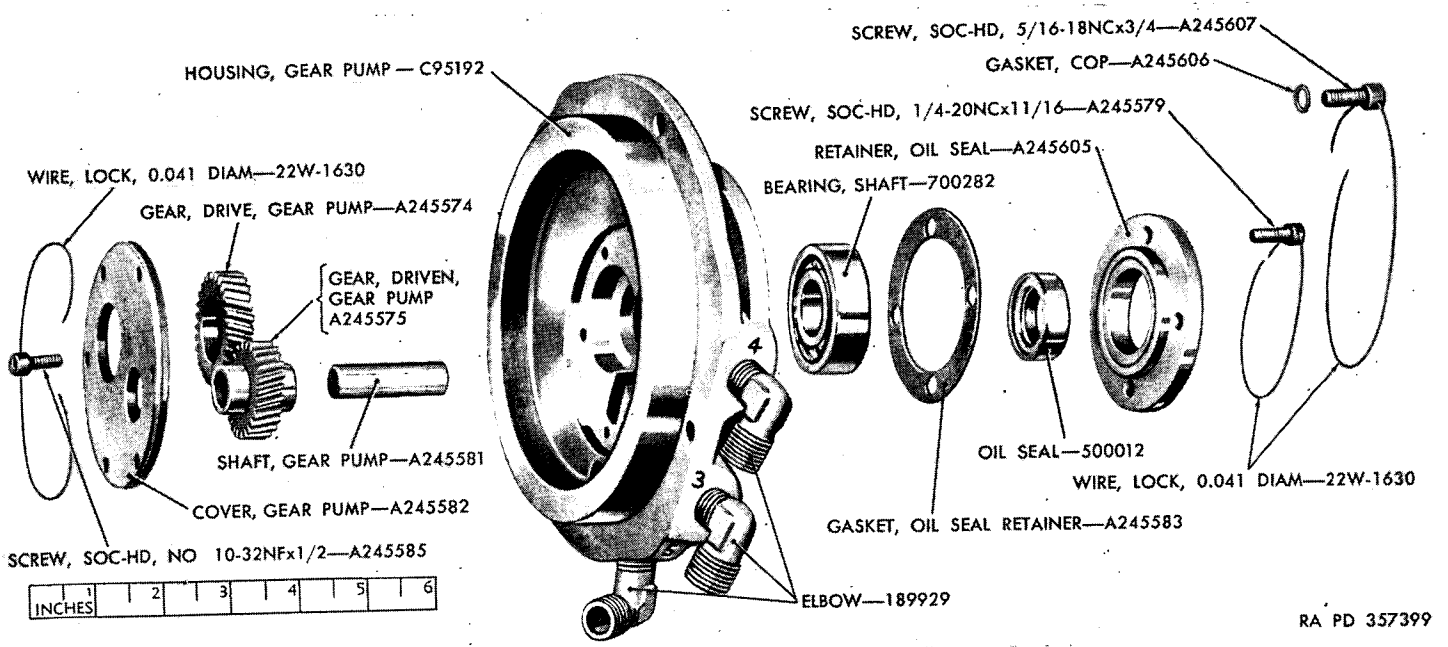


Figure 38. Hydraulic pump gear pump housing, exploded view.

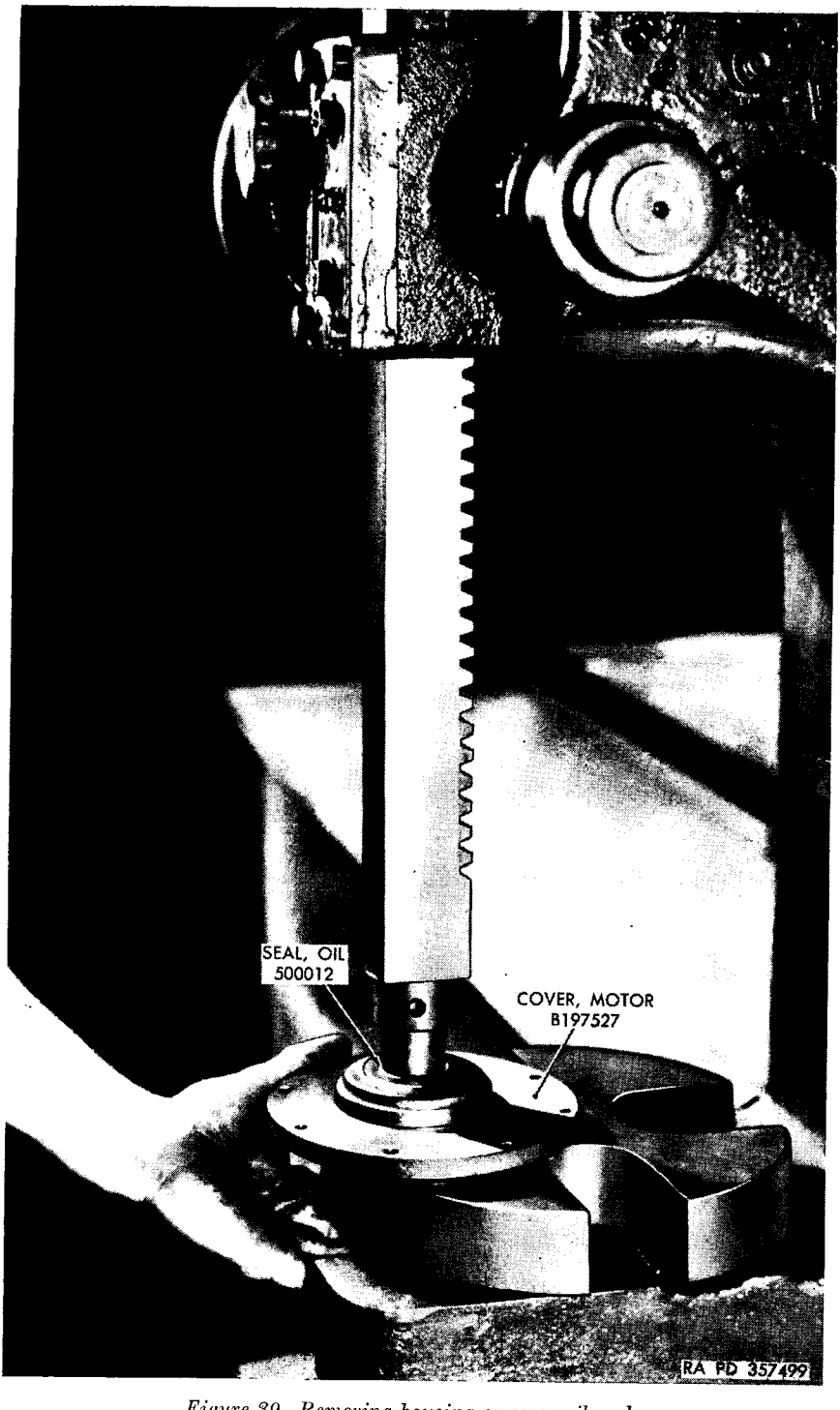


Figure 39. Removing housing or cover oil seal.

screw to drive shaft and pull gear pump housing off of drive shaft. Lift shaft, cylinder, roller bearing, and rear ball bearing out of case. If shaft unit sticks in case, tap ported end of drive shaft with a brass bar.

e. Disassemble Gear Pump Housing Assembly (figs. 38 and 39). Cut and remove lock wire from six cover mounting screws. Remove six screws. Remove cover from gear pump gears. Lift out the two gear pump gears and shaft bushing. If necessary, the straight gear pump stub shaft can be pressed or tapped out of housing the short way. Cut and remove lock wire from four oil seal retainer screws. Remove four oil seal retainer screws, if not previously removed. Lift out oil seal retainer assembly and gasket. If oil seal is worn, press oil seal out of retainer (fig. 39). Slide or tap shaft front ball bearing out of gear pump housing.

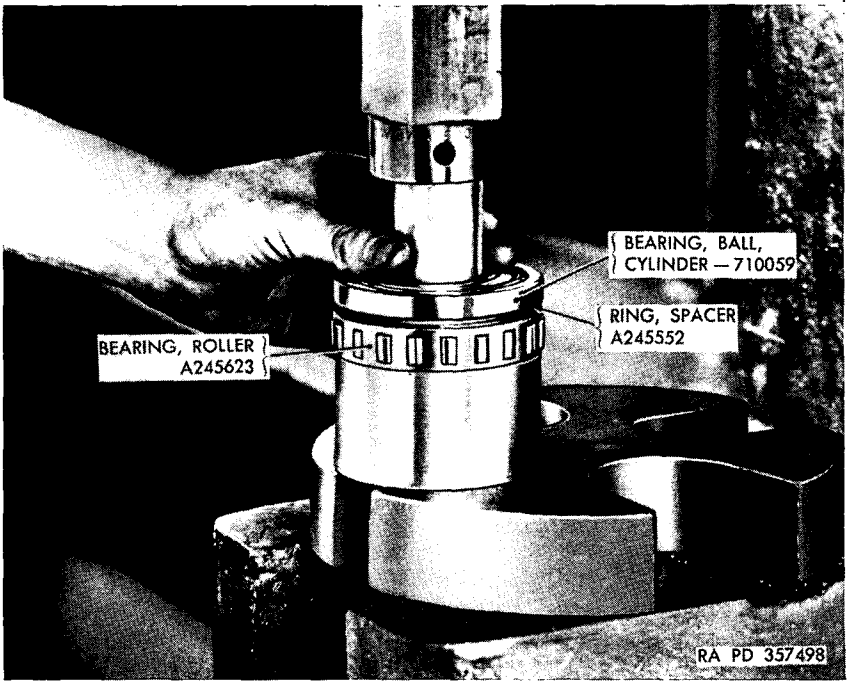


Figure 40. Pressing roller bearing, spacer ring, and ball bearing off pump shaft.

f. Disassemble Drive Shaft, Cylinder, Pistons, and Bearing Assembly (figs. 40 and 41). Place assembly in press with ported end of drive shaft up. Force spacer ring and roller bearing off cylinder. Lift rolling pistons out of cylinder. If a rolling piston sticks in a cylinder hole, insert a No. 8–32 screw in end of piston to pull it out.

CAUTION: Do not press cylinder off shaft.

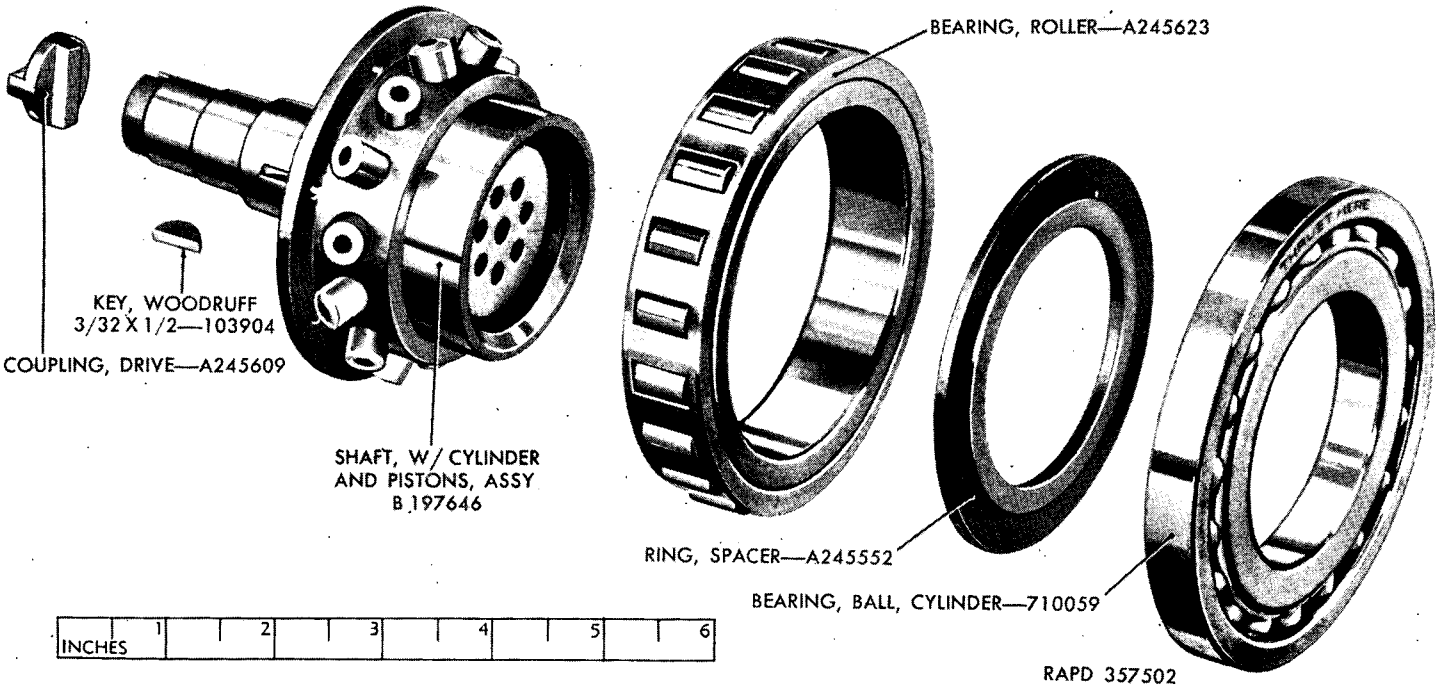


Figure 41. Hydraulic pump drive shaft with cylinder and piston assembly, and related parts.

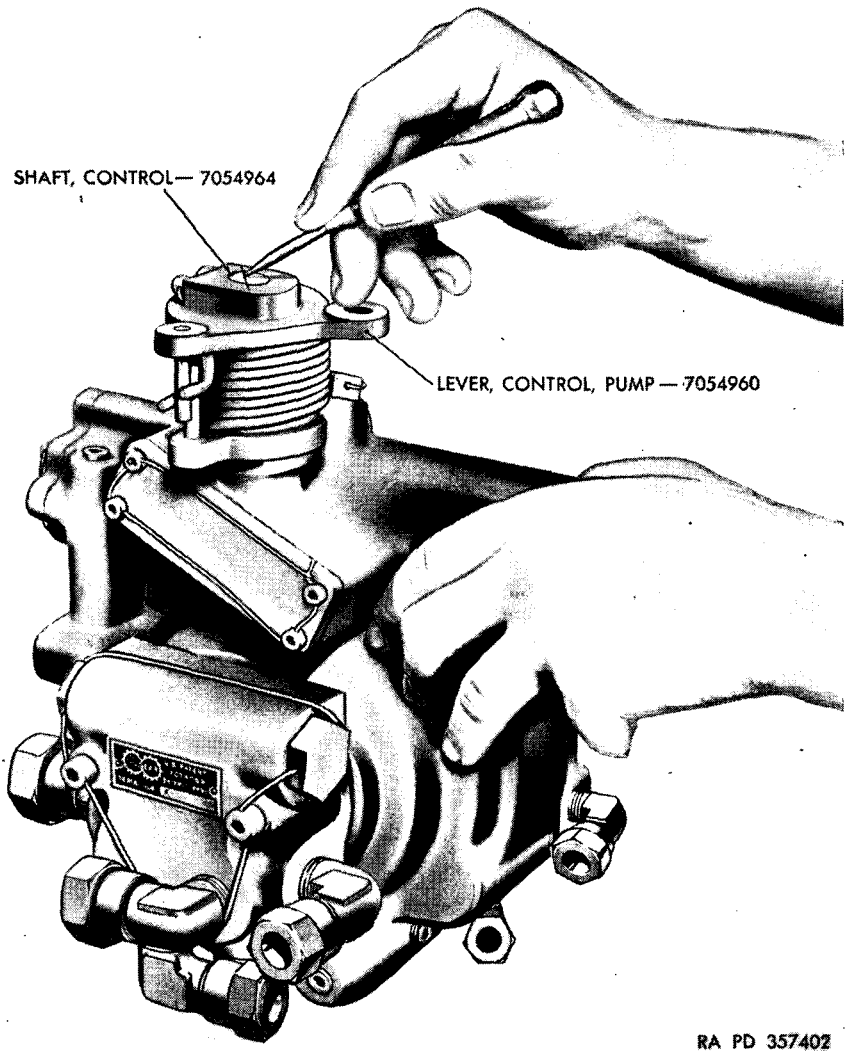


Figure 42. Scratching mark on hydraulic pump control lever and shaft.

g. Disassemble Eccentric Control Shaft Assembly (figs. 16, 19, 20, 42, 43, and 44). Scratch a mark across eccentric control shaft and spring-centered control lever to assure assembly of shaft and control lever in the proper position. Cut and remove lock wire on adjusting screws. Loosen both adjusting screws on control lever sufficiently to clear machined flat on eccentric control shaft. Lift control lever off control shaft. Lift centering spring off control housing. Cut and remove equalizer bar cover lock wire. Remove equalizer bar cover screws. Take off cover and gasket. Remove control shaft housing screws and lock washers. Depress equalizer bar

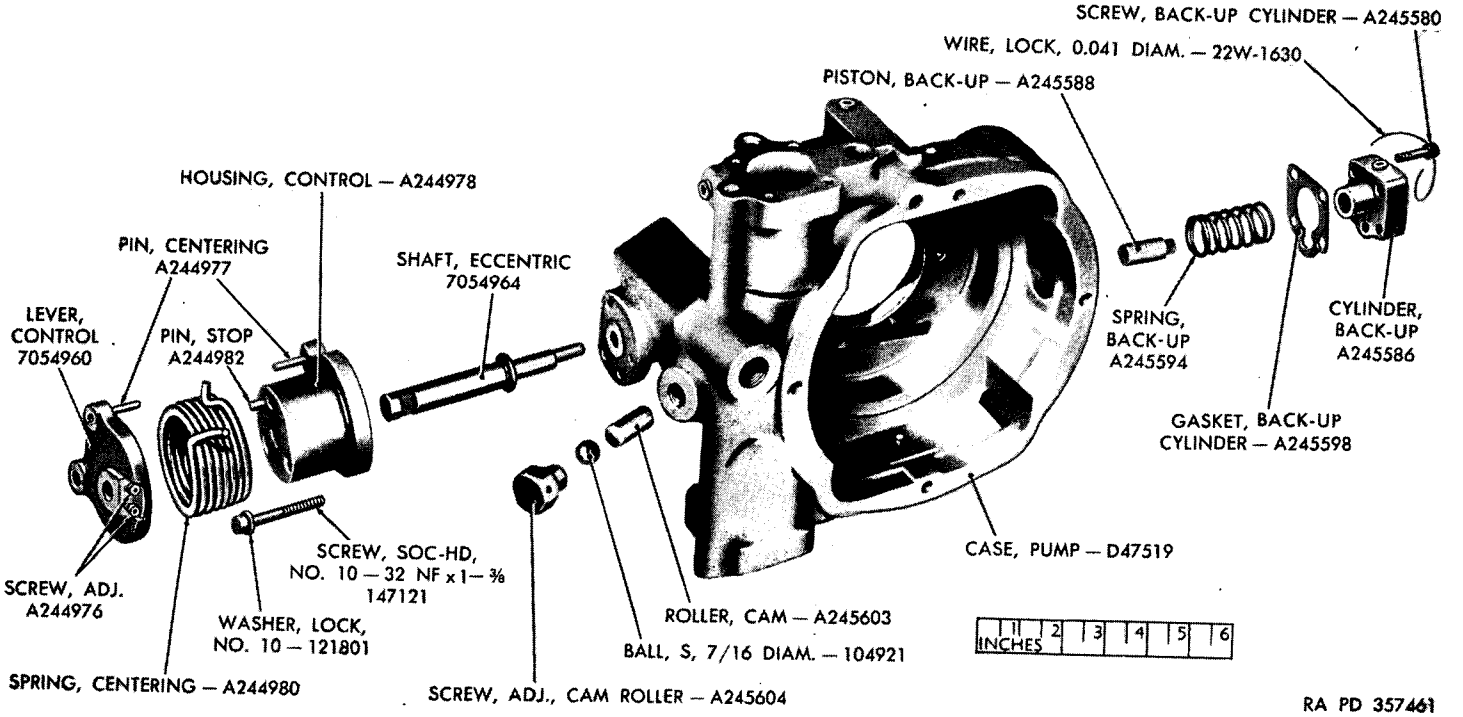


Figure 43. Hydraulic pump eccentric control and back-up piston, exploded view.

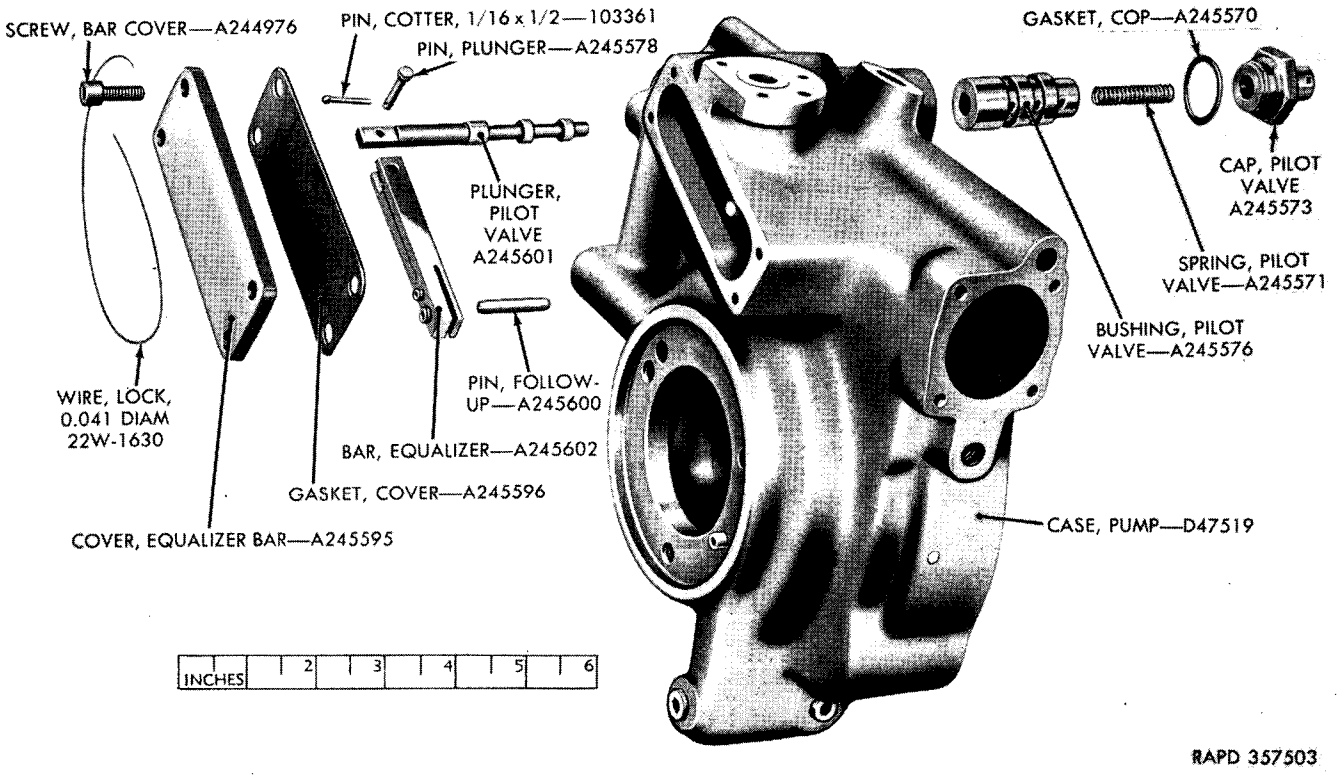


Figure 44. Hydraulic pump equalizer bar and pilot valve plunger, exploded view.

with thumb of one hand and lift off control shaft housing, gasket, and shaft with the other hand. Slip control shaft out of housing. Do not adjust or remove either set screw in the equalizer bar. Pull out equalizer bar and pilot value plunger assembly. Pull out follow-up pin. Cut and remove lock wire in pilot valve plunger spring cap. Remove cap, gasket, and spring. If pilot valve plunger bushing must be removed, place pump case in a press and force bushing out through the pilot valve plunger cap end.

h. Remove Slide Block Race, Slide Block Back-Up Piston Cylinder, And Control Cam Assembly (figs. 16, 17, 43, 45, and 46). Remove screws holding caged roller pins in place. Remove washers and caged roller pins. Lift slide block race out of case. Remove slide block race roller cages and plates from case.

Note. In removing caged rollers and plates, look carefully for a shim between the plate and the case. This shim will not appear in every pump. This shim must be assembled on the same side of the case as it was in disassembly. Scribe a mark on the case, indicating the side with the shim, so that there can be no error in assembly.

Cut and remove back-up piston cylinder screw lock wire. Remove screws. Pry back-up piston cylinder off connector in case, being careful to prevent damaging connector between cylinder and case. Remove gasket. Remove slide block back-up piston and spring. Cut and remove lock wires from both control cam piston bore control cylinders. Remove covers and gaskets. Apply finger pressure on small control cam piston and push the large control cam piston and cam assembly out of large control cam piston end. Push small piston out of its bore. Do not remove cotter pin and separate large piston from cam.

i. Remove Control Cam Back-Up Roller (figs. 16, 20, and 43). Add a scratch mark to control cam back-up roller screw and to pump case, in order to facilitate assembly. Remove screw. Ball and roller are free to be removed. Do not remove screw unless replacement is necessary. Back-up roller and ball can be removed from inside case without removing screw.

28. Cleaning

Flush parts with dry-cleaning solvent or volatile mineral spirits paint thinner. Be sure to clean balancing grooves on slide block back-up piston, equalizer pistons, end head back-up pistons, and control cam pistons. Clean out hole in bottom of each radial piston. Dry out excess solvent or paint thinner with compressed air.

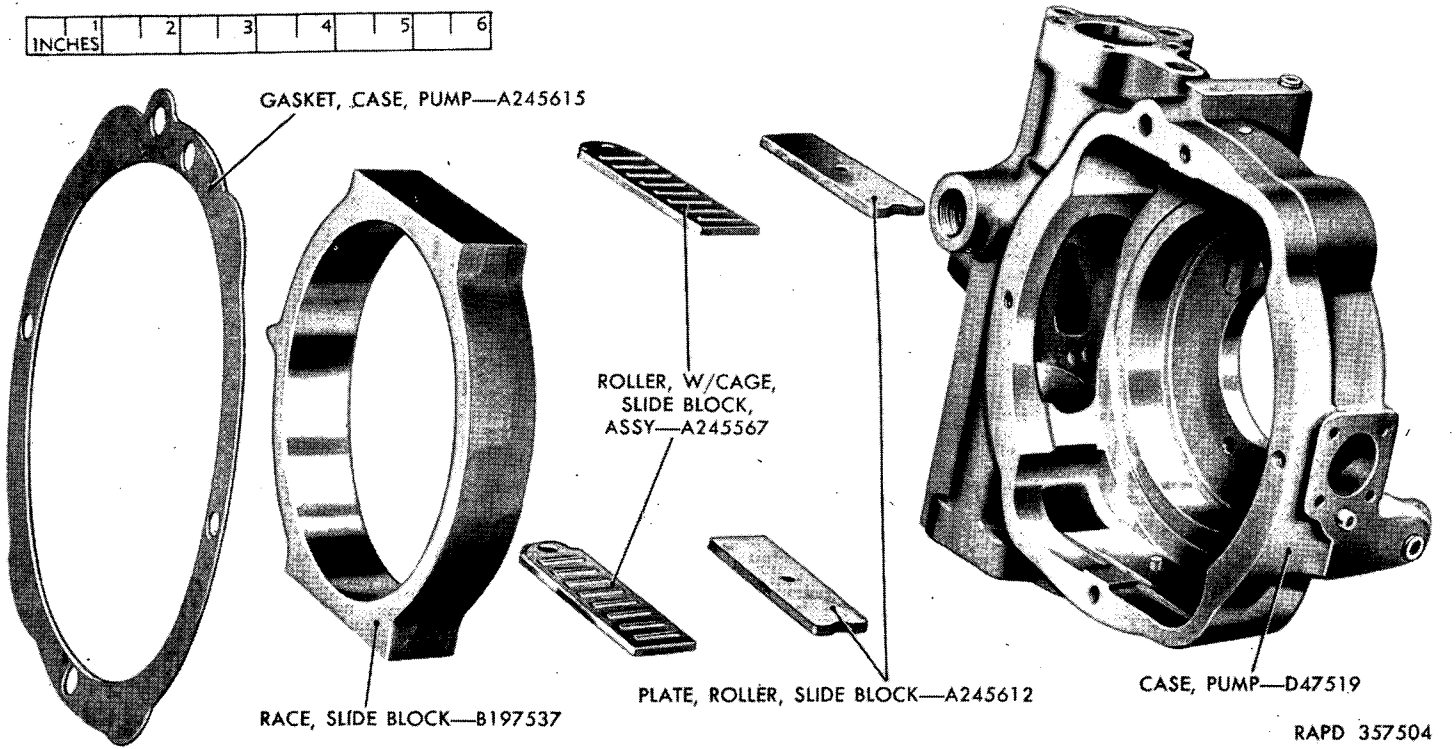


Figure 45. Hydraulic pump slide block race, exploded view.

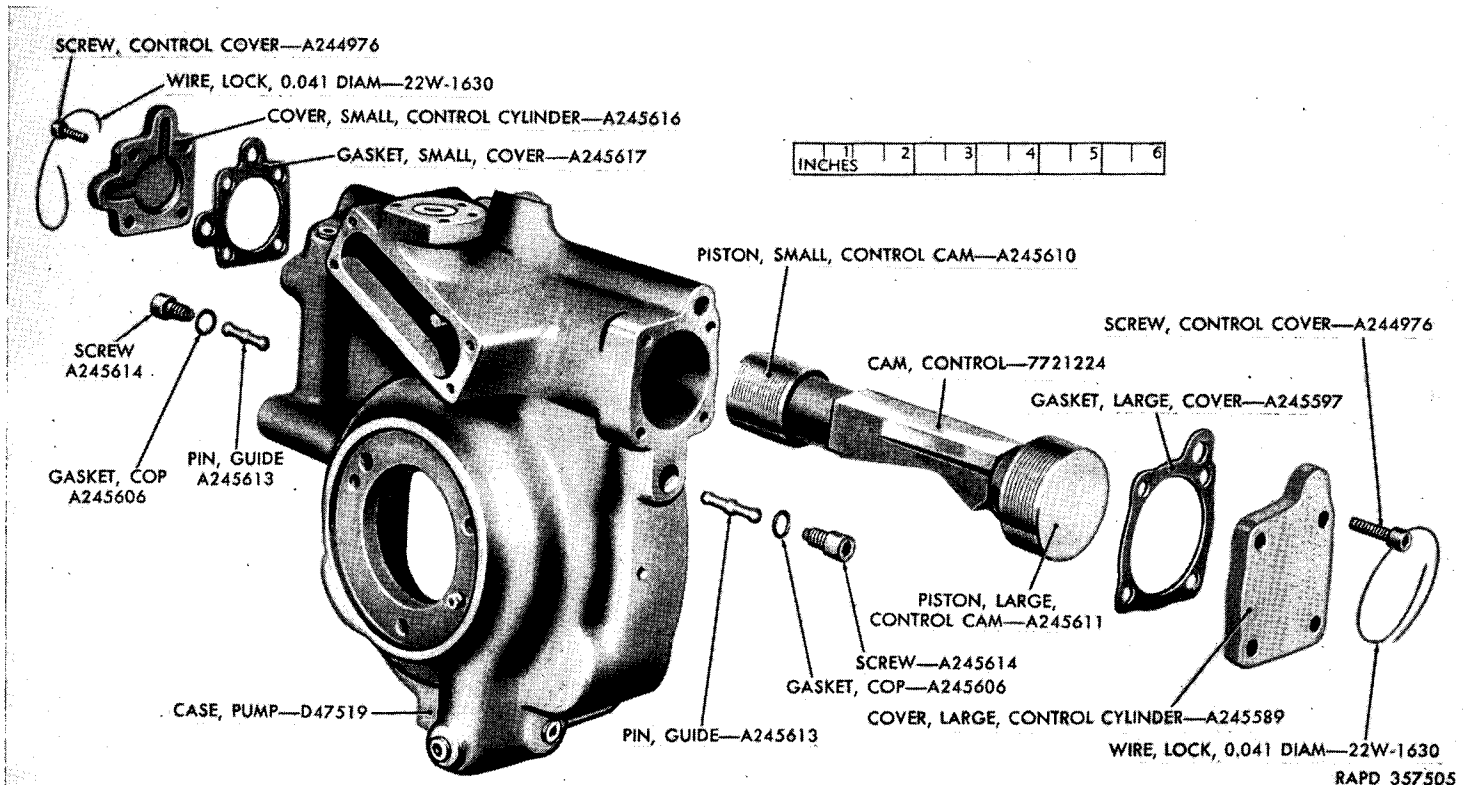


Figure 46. Hydraulic pump control cam and piston, exploded view.

29. Inspection and Repair

a. INSPECTION.

(1) *Inspect bearings.*

Note. Refer to paragraph 68 for sizes and fits.

To test for galling, pitting, and flat spots on balls, rollers, or races, hold inner race stationary with axis horizontal, press down firmly and partially rotate outer race in both directions. Try at different areas around bearing.

Note. Do not apply any end thrust in the wrong direction or an erroneous test will result.

Oil in bearing will mask bad spots. Check for wear on inner race of roller bearing. Inspect slide block rollers for flat spots. Check slide block roller plates and corresponding surfaces on slide block race for scoring or grooves. Inspect nose and inside of slide block race for scoring.

(2) *Inspect drive shaft and control shaft oil seals.* Inspect wiping edge of oil seals. It must be sharp and free from cracks and cuts.

(3) *Inspect flat valve.* Face of flat valve should be flat and free of wear spots or scoring, especially on bridges between ends of crescents. Check sizes and fits of equalizer pistons and holes in flat valve (par. 68).

(4) *Inspect back-up pistons.* Check sizes and fits of three back-up pistons and holes in end heads, and slide block back-up piston in cylinder (par. 68). Inspect concave surfaces in back-up pistons and convex surfaces on tumblers for pitting or score marks.

(5) *Inspect control cam and pistons.* Check sizes and fits of large and small control cam pistons and holes in pump case. Inspect cam surfaces for wear or scoring.

(6) *Inspect springs.* Check for broken or fatigued springs. Test end head back-up piston springs, slide block back-up piston spring, check valve springs, pilot valve spring, and control lever spring for proper force (par. 68).

(7) *Inspect drive shaft, cylinder, and piston assembly.* Inspect beveled surface on bearing contact end of each piston for flat spots. Check sizes and fits of rolling pistons and cylinder holes (par. 68). Inspect cylinder holes for scoring or bellmouthing.

(8) *Inspect check valves.* Inspect check valve seats for scoring or foreign material. Check disks for foreign material.

(9) *Inspect gear pump and gear pump housing.* Check gear pump gears for broken, chipped, scored, or worn teeth. Check clearances on sides and diameters of gears (par. 68). Inspect housing counterbores for worn spots or deep grooves.

(10) *Inspect eccentric control shaft and pilot valve assembly.* Check eccentric end of control shaft for marred surface. Check size and fits of control pilot valve plunger and bushing (par. 68). Inspect control pilot valve bushing for scoring or foreign material. Check position of bushing in case (fig. 68). Be sure follow-up pin is free in hydraulic pump case and that control cam end is not worn flat.

(11) *Inspect control cam back-up roller.* Inspect roller for flat spots on beveled edge and for size and fit (par. 68). Check ball for flat spots or pitted surface.

b. REPAIR.

(1) *Lap pistons.* If necessary, lap radial rolling pistons into cylinder, back-up pistons into end head, tumblers into back-up pistons, equalizer pistons into flat valve, slide block back-up piston into flange, control cam pistons into pump case, control cam back-up roller into pump case, pilot valve plunger into bushing, and gear pump gears into housing, with fine ground pumice and light lubricating oil. Fasten cover over gear pump gears before lapping. Use a small bar or any other conventional lapping tool which will fit in the keyways in the driver gear for turning purposes. Flush out all pumice with dry-cleaning solvent or volatile mineral-spirits paint thinner. Dry out excess solvent or paint thinner with compressed air. Coat surfaces with hydraulic oil.

(2) *Replace shaft, cylinder, and piston assembly.* If holes in cylinder are scored or bellmouthed, replace entire shaft, cylinder, and piston assembly.

(3) *Replace gear pump assembly.* If there are deep grooves in the housing counterbores that cannot be lapped out, replace the gear pump housing assembly.

(4) *Replace defective springs, plungers, pistons, bearings, and oil seals.* Refer to paragraph 68.

30. Assembly

a. GENERAL. Refer to paragraph 27*a* before proceeding with assembly. Use new gaskets to avoid leaks.

b. ASSEMBLE CONTROL CAM ASSEMBLY AND BACK-UP ROLLER (figs. 16, 20, 46, 123, and 127). If back-up roller was not removed, be sure roller and ball are in place with beveled end of roller on cam (fig. 20). If roller and ball were removed through inside of case, insert ball and roller, with beveled edge of roller touching control cam. If large piston was removed from control cam, slip it on the short turned end and lock it to cam with the cotter pin. Insert small piston end of control cam into case through large piston hole, with cam contour

facing center of case for contact with slide block race nose. Slip small piston into case hole and onto control cam. If back-up roller and screw were removed, insert roller in hole so that the beveled edge contacts cam. Insert the ball and tighten back-up screw until the previous scratch marks line up. *Do not* change the setting of this screw by over or under tightening it. Slide pistons and control cam back and forth to be sure assembly is free to move the case bore.

c. Assemble Slide Block Race and Back-Up Piston Cylinder (figs. 16, 43, 45, and 123). Insert the caged roller plates over pins inside of case.

Note. Include shims between plates and case as were previously removed (par. 27*h*).

Set slide block race in case with nose facing control cam. Insert the two caged rollers between the ground surfaces on slide block race and plates. Put hole end toward the control cam. Insert caged roller pins through holes in case, through caged rollers, and into drilled holes in slide block race. Place screws and washers behind pins, and tighten screws to case. Insert flat end of slide block race back-up piston into cylinder. Place spring and gasket over cylinder tongue. Fasten cylinder to case with four screws. Be sure the connector between the case and cylinder fits into the cylinder correctly before tightening mounting screws. Wire screws in place with lock wire.

d. Assemble Pilot Valve and Equalizer Bar (figs. 2, 19, 44, and 126). If pilot valve plunger bushing was removed, insert small end into cap end of hole and press bushing into hydraulic pump case, to the dimension shown in figure 126. Insert pilot valve plunger into bushing. Check to see if plunger will move freely. Lap plunger in bushing, if necessary. Affix equalizer bar to outer end of plunger with straight pin and cotter pins. Insert control cam follow-up pin in hole and against control cam. Insert pilot valve spring over end of pilot valve plunger. Slide copper gasket over cap, place cap over spring, and screw it in place.

e. Assemble Control Shaft Assembly (figs. 2, 43, 123, and 127). If control shaft oil seal was removed, slip a new one on control shaft, with closed end toward shoulder. Slide or tap shaft and seal into hydraulic pump case. Be sure that oil seal is not cocked in assembly.

Note. Depress equalizer bar at the same time so that control shaft will be outside of bar. Be sure that set screw near end of bar rests on control cam follow-up pin.

Slip gasket and housing over control shaft. Set lug on housing toward end head (fig. 2). Fasten housing to case with three screws and lock washers. Slip centering spring over housing and compress protruding ends of spring as they slip over pin to provide tension for spring centering in each direction. To eliminate play, be sure tongues on centering spring contact the pins in both control lever and housing.

Line up scribe mark on shaft and control handle, and tap control lever onto control shaft.

Note. Be sure pin is between protruding ends of centering spring and machine flat on shaft faces the two adjusting screws in control lever.

Tighten the two adjusting screws to carefully line up scratch marks on control shaft and control lever. Actuate control lever to see if control shaft operates equalizer bar. Slide control cam and piston assembly back and forth with thumbs to be sure pistons are free and follow-up pin moves equalizer bar.

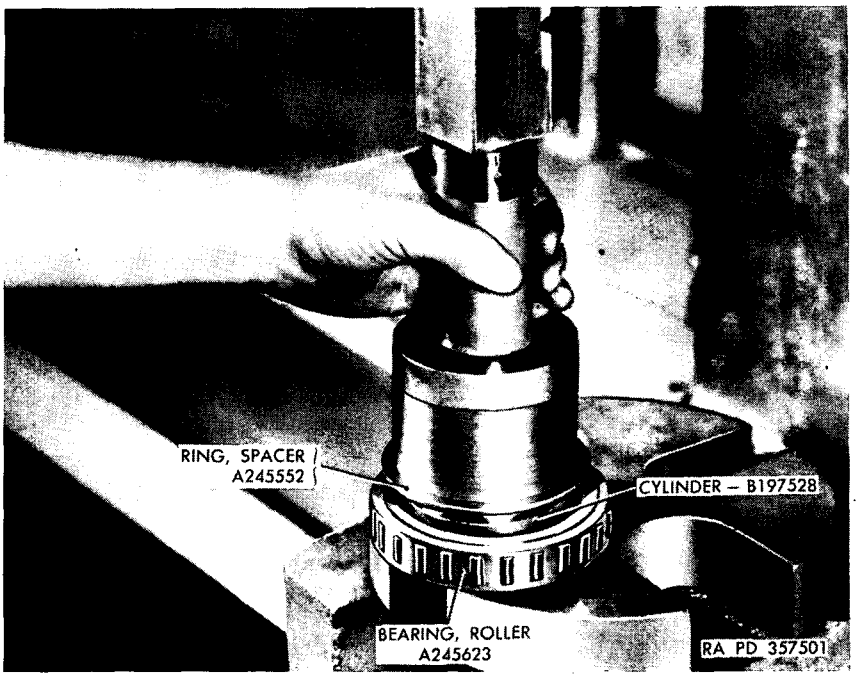


Figure 47. Pressing spacer ring onto shaft with cylinder and piston assembly.

f. Assemble Drive Shaft, Cylinder, Pistons, and Bearing Assembly (figs. 41, 47, 48, and 124). Insert fourteen pistons, with beveled ends outward, into cylinder. All pistons should go into cylinder holes far enough to be flush with turn on cylinder. Place cylinder, shaft, and piston assembly in an arbor press (fig. 47). Place roller bearing over the pistons in cylinder and press spacer ring, with hub end toward rear ball bearing, onto cylinder hub. Then press rear ball bearing onto cylinder hub (fig. 48). Arrange rear ball bearing with surface marked "THRUST HERE" away from spacer ring.

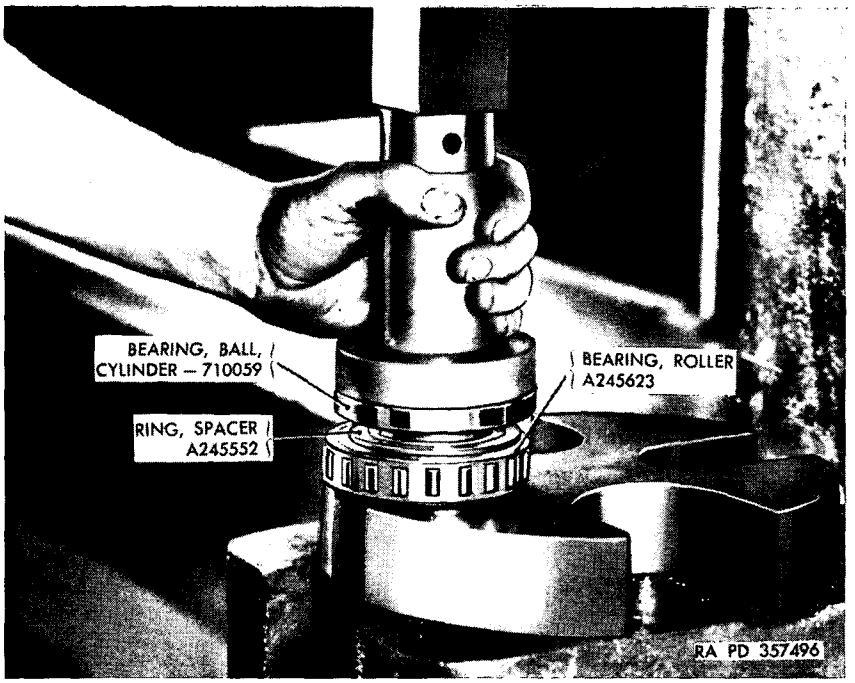


Figure 48. Pressing rear ball bearing onto cylinder, piston, and shaft assembly.

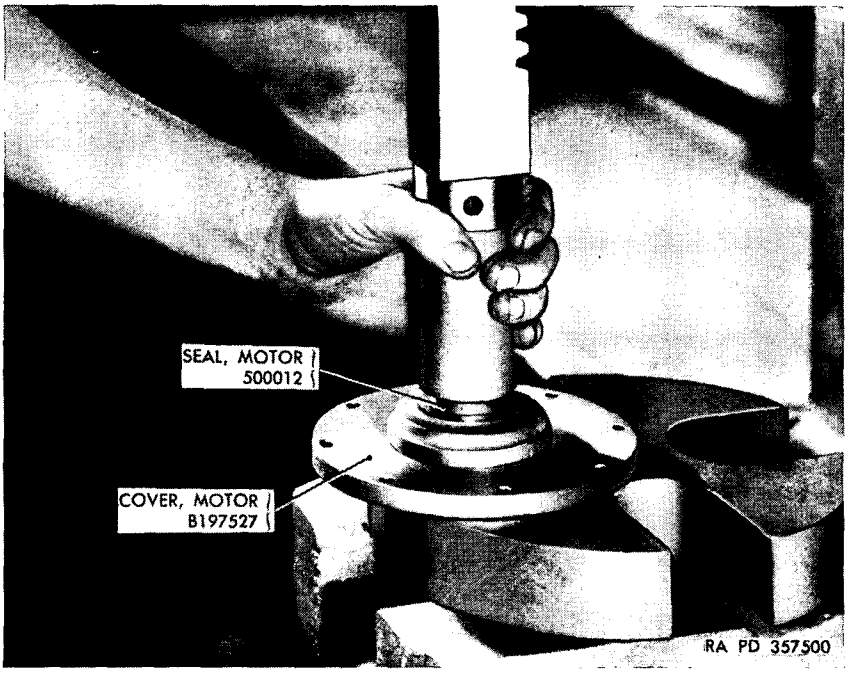


Figure 49. Pressing oil seal into oil seal retainer and cover.

g. Assemble Gear Pump Housing Assembly (figs. 2, 38, 49, and 124). Press gear pump shaft in housing the short way and flush with housing front face. Slip gear pump driven gear and bushing over shaft. Insert gear pump drive gear. Turn gears to see if they are free. Fasten gear pump cover to housing with six screws. Wire screws in place with lock wire. Insert front ball bearing into counterbore of housing with bearing surface marked "THRUST HERE" facing oil seal retainer. Place gear pump housing assembly in an arbor press, front face down, with front ball bearing resting on a replacer, the two holes being concentric. Insert shaft into drive gear and ball bearing and be sure key fits in shaft and either drive gear keyway. Place a bar on ported end of drive shaft and force shaft assembly down until shoulder on shaft reaches front ball bearing. Place oil seal retainer on arbor press (fig. 49) with tongue downward. Set oil seal in place with closed end on top, and press oil seal flush with housing. Fasten gasket and oil seal retainer to gear pump housing with four screws. Wire screws in place with lock wire.

h. Assemble Shaft, Gear Pump, and Case Assemblies (figs. 2, 36, 123, 124, and 126). Make certain slide block race is in neutral position. Press on control cam pistons with fingers to actuate pistons and cam until bore in slide block race is concentric with counterbore in case and rear ball bearing. Place housing gasket properly on case and insert shaft and gear pump housing assembly into case. See figure 2 for position of gear pump suction and discharge ports 3 and 4 in relation to hydraulic pump case. Place gaskets on the two screws closest to pilot valve cap and slide block back-up piston cylinder. Fasten housing to case with four screws. Wire screws with lock wire. Fasten the two control cam piston gaskets and covers to pump case with eight screws. Wire cover screws and roller cage pin screws in place with lock wire. Wire pilot valve spring cap and control cam back-up piston screws in place with lock wire. Fasten equalizer bar gasket and cover with four screws. Wire cover screws in place with lock wire. Tap or press ported end of drive shaft to be sure shaft shoulder is tight against front ball bearing. Be sure ported end of drive shaft and rear ball bearing are kept free of brass chips or dirt.

i. Assemble End Head Assembly (figs. 2, 17, 18, 33, 34, 35, and 124). Lay name-plate surface of end head on two small blocks to straddle elbow fitting. Insert, in the order given the two small back-up springs, pistons, and tumblers into their respective small holes. Also in the order given, insert the large back-up spring, piston, and tumbler into the large hole. Be sure hold-down tumblers fit into concave end of back-up pistons. Insert the two equalizer pistons into their respective holes in flat valve with tapped ends outward. Slip flat valve, with crescents on top, over retaining pins in end head. Make certain that the large hole in the flat valve fits over the large hole in the end head. Depress flat valve sufficiently with thumb

(fig. 33) to insert the two lock pins. Insert check valve disks and springs into holes in sides of end head. Slide copper gaskets on caps and screw caps down securely over the springs.

j. Assemble End Head Assembly to Case (figs. 2 and 124). Set end head gasket in case counterbore to match drilled holes in case and fasten end head in place with four screws. See figure 2 for position of end head ports 1 and 2 in relation to pump case. The connector between the case and the end head must fit into the hole in the end head. Wire screws and check valve caps in place with lock wire. Do not wire the two adjusting screws on control lever until pump is tested.

31. Test Before Installation

Refer to paragraphs 63 and 64.

Section IV. REBUILD OF CONSTANT-DISPLACEMENT HYDRAULIC MOTOR

32. Disassembly

a. General. Refer to paragraph 27*a*.

b. Remove End Head Assembly (fig. 3). Remove lock wire from end head mounting screws. Remove four mounting screws with gaskets. Lift off end head assembly and gasket.

c. Disassemble End Head Assembly (figs. 33, 50, and 128). Lay end head on name-plate surface, depress flat valve lightly with thumb, and pull out two lock pins (fig. 33). Lift off flat valve and hold-down tumblers. Remove back-up pistons and back-up springs. Lift out two equalizer pistons from flat valve. If necessary, insert a No. 8–32 screw in pistons to remove pistons. Mark small back-up pistons and equalizer pistons so as to facilitate assembly in their respective holes. Two retaining pins are pressed into end head and should not be removed unless replacement is necessary. Do not loosen or remove tube fittings and nipples unless replacement is necessary.

d. Remove Cover Assembly (figs. 51 and 128). Remove cotter pin holding coupling onto shaft. Slide coupling off shaft. Lift Woodruff key off shaft. Scratch a mark across motor cover and case to assure assembly in the proper position. Remove four cover mounting screws. Slide motor cover assembly off shaft. If cover is tight, pry off case.

Caution: Be sure sharp edges on shaft keyway do not cut oil seal. If necessary, use a shim over keyway to protect oil seal.

e. Disassemble Shaft Oil Seal (fig. 39). If replacement of shaft oil seal is necessary, press oil seal out of cover.

f. Remove Drive Shaft Assembly (fig. 51). Tap ported end of drive shaft firmly with brass bar until drive shaft, cylinder, pistons,

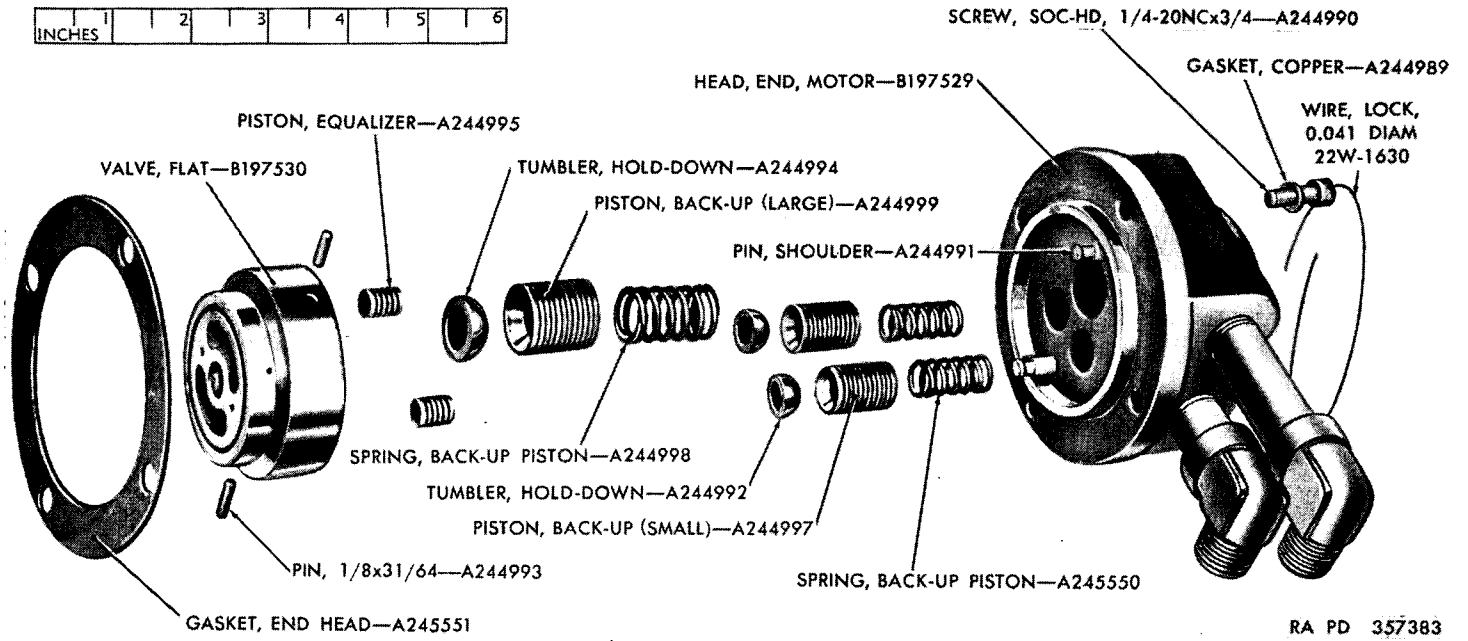


Figure 50. Hydraulic motor end head assembly, exploded view.

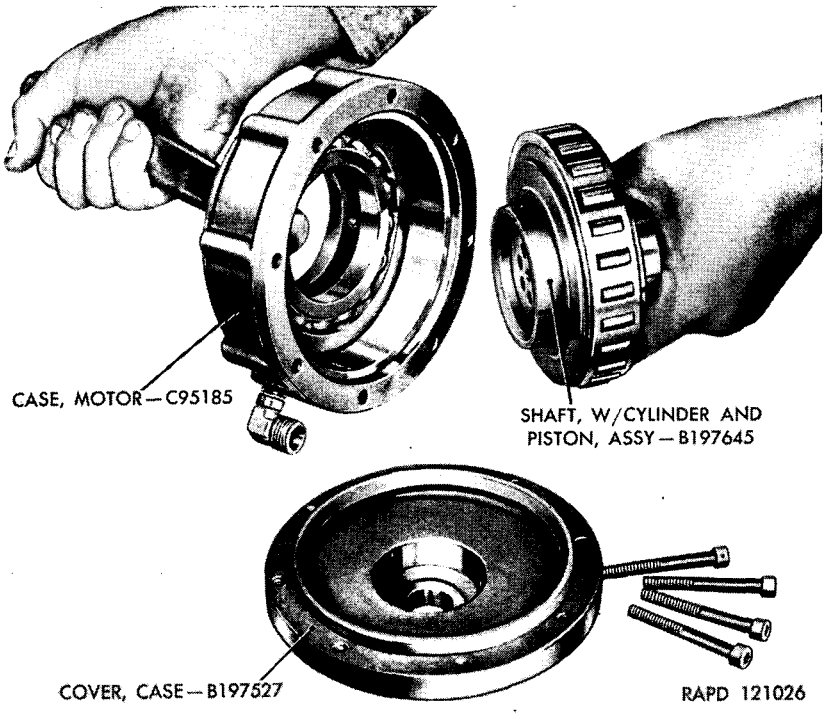


Figure 51. Removing hydraulic motor shaft, cylinder, pistons, and roller bearing.

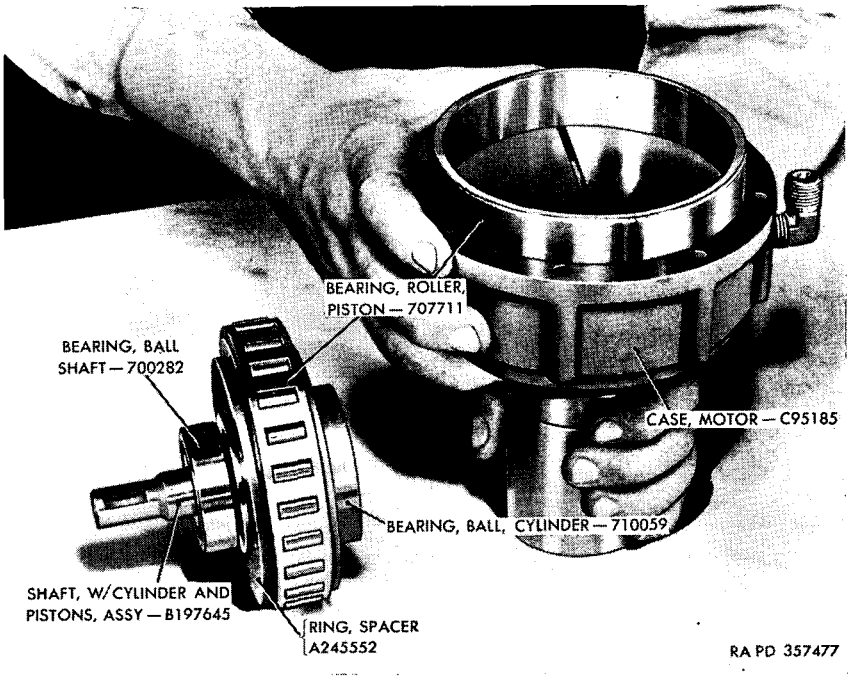


Figure 52. Removing outer roller bearing race from hydraulic motor case.

roller bearing, and spacer ring are free from case. Usually, the outer race of roller bearing and the rear ball bearing remain in the motor case. In remote cases, the outer race of roller bearing and the rear ball bearing will come out with the shaft assembly.

g. Remove Outer Race of Roller Bearing and Rear Ball Bearing (fig. 52). Hold case in both hands and strike case, face down, firmly against bench to force outer race of roller bearing flush with face of case. Push the rear ball bearing back into position and insert the two circular segments into position (fig. 52), between the outer race and rear ball bearing. Place small bore in case over a bar until bar rests against the two circular segments. Hold case and bar tight in both hands and strike parts firmly on bench. Repeat operation until outer race is out of case. Lift or tap rear ball bearing out of case.

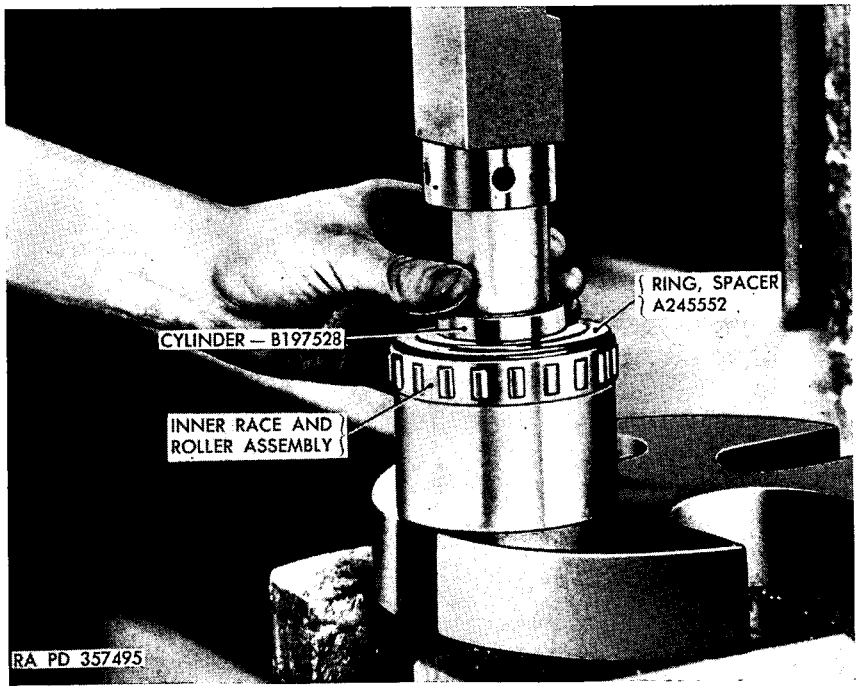


Figure 53. Removing hydraulic motor roller bearing and spacer ring.

h. Disassemble Drive Shaft Assembly (figs. 21, 22, 53, 54, and 128). Place assembly in press with ported end of drive shaft up (fig. 53). Force spacer ring and roller bearing off cylinder. Lift rolling pistons out of cylinder. If a rolling piston sticks in a cylinder hole, insert a No. 8–32 screw in end of piston to pull it out. Front ball bearing should not be removed from drive shaft unless bearing is worn and needs replacement. To remove front ball bearing, insert

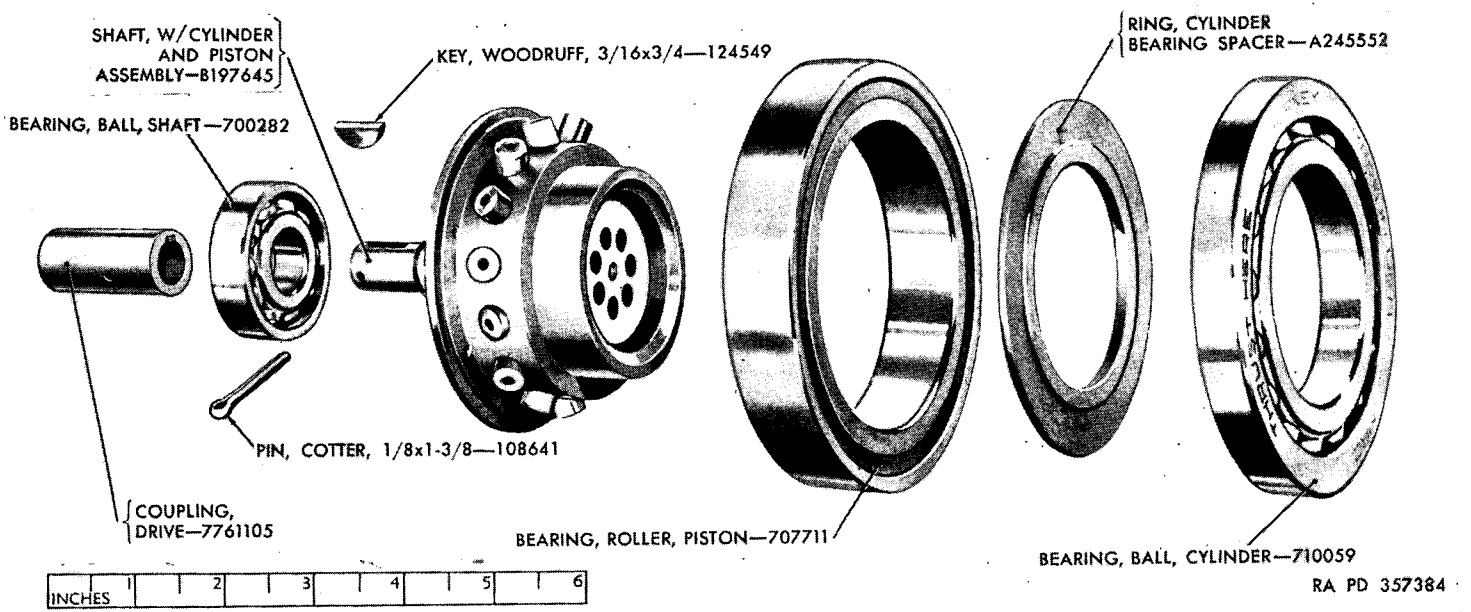


Figure 54. Hydraulic motor shaft assembly, exploded view.

bearing puller between bearing and cylinder, place in press and force out shaft and cylinder.

Caution: Do not press cylinder off shaft.

33. Cleaning

Flush parts with dry-cleaning solvent or volatile mineral spirits paint thinner Be sure to clean balancing grooves on equalizer pistons and back-up pistons. Clean out hole in bottom of each radial piston. Dry out excess solvent or paint thinner with compressed air.

34. Inspection and Repair

a. Inspection.

(1) *Inspect bearings.*

Note. Refer to paragraph 69 for sizes and fits.

To test for galling, pitting, and flat spots on balls, rollers or races, hold inner race stationary with axis horizontal, press down firmly, and partially rotate outer race in both directions. Try at different areas around bearing.

Note. Do not apply any end thrust in the wrong direction or an erroneous test will result. Any oil in bearing will mask bad spots.

Check for wear on inner race of roller bearing.

(2) *Inspect shaft oil seal.* Inspect wiping edge of oil seal. It must be sharp and free from cracks or cuts.

(3) *Inspect flat valve.* Face of flat valve should be flat and free of wear spots or scoring, especially on bridges between ends of crescents. Check sizes and fits of equalizer pistons and holes in flat valve (par. 69).

(4) *Inspect back-up pistons.* Check sizes and fits of the three back-up pistons and holes in end head (par. 69). Inspect concave surfaces in back-up pistons and convex surfaces on tumblers for pitting or score marks.

(5) *Inspect back-up piston springs.* Check for broken or fatigued springs. Test all springs for proper force (par. 69).

(6) *Inspect drive shaft, cylinder, and piston assembly.* Inspect beveled surface on bearing contact end of each piston for flat spots. Check sizes and fits of rolling pistons and cylinder holes (par. 69). Inspect cylinder holes for scoring or bell-mouthing.

b. Repair.

(1) *Lap pistons.* If necessary, lap radial rolling pistons into cylinder, back-up pistons into end head, tumbers into back-up pistons, and equalizer pistons into flat valve with fine ground pumice and light lubricating oil. Flush out all pumice with dry-cleaning solvent or volatile mineral-spirits

paint thinner. Dry out excess solvent or paint thinner with compressed air. Coat surfaces with hydraulic oil.

(2) *Replace shaft, cylinder, and piston assembly.* If holes in, cylinder are scored or bellmouthed, replace entire shaft, cylinder, and piston assembly.

(3) *Replace defective springs, plungers, bearings, and shaft oil seal.* Refer to paragraph 69.

35. Assembly

a. General. Refer to paragraph 27*a* before proceeding with assembly. Use new gaskets to avoid leaks.

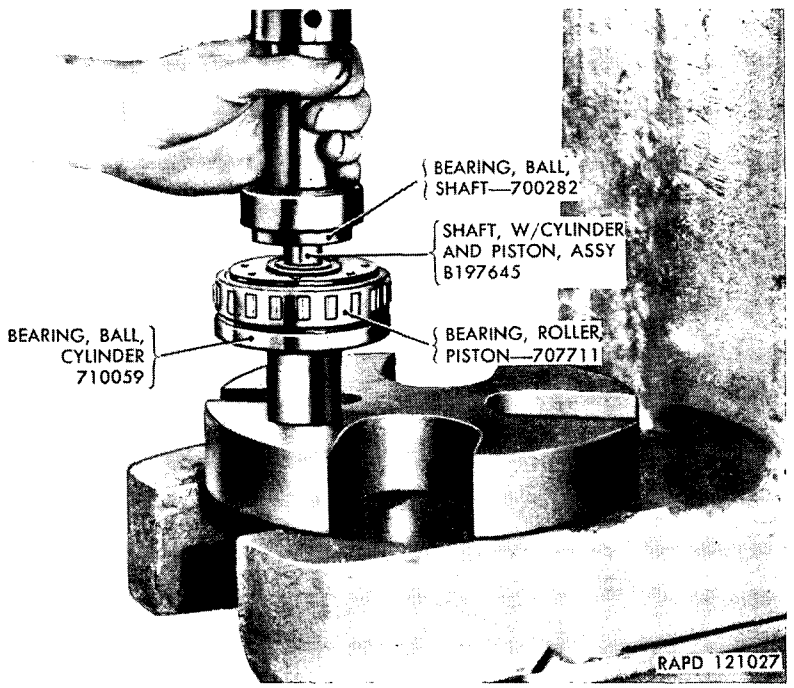


Figure 55. Pressing front ball bearing onto hydraulic motor shaft.

b. Assemble Drive Shaft, Cylinder, Pistons, and Bearing Assembly (figs. 21, 47, 48, 54, 55, and 128). Insert 14 rolling pistons, with beveled ends outward, into cylinder. All pistons should go into cylinder holes far enough to be flush with turn on cylinder. Place cylinder and shaft assembly in an arbor press (fig. 47). Place roller bearing over the pistons in cylinder and press spacer ring, with hub end toward ball bearing, onto cylinder hub. Press rear ball bearing onto cylinder hub (fig. 48). Arrange rear ball bearing with surface marked "THRUST HERE" away from spacer ring. Place ported

end of shaft on a brass bar and press front ball bearing on shaft with surface marked "THRUST HERE" away from cylinder (fig. 55).

c. Assemble Case, Race, and Shaft Assembly (figs. 21 and 128). Set outer roller bearing race in case bore and tap or press race about half way into case. Insert drive shaft, cylinder, pistons, and bearings assembly into case. Tap or press outer roller bearing race so it bottoms in case bore.

d. Assemble Cover Assembly (figs. 49 and 128). Place cover in an arbor press with inside face downward. Set oil seal in place with closed end on top and press seal flush with cover face.

e. Assemble Cover to Case (figs. 3 and 128). Place motor-cover gasket on case and carefully thread cover assembly over shaft to motor case to avoid cutting oil seal on keyway in shaft. If necessary, use a shim over keyway to protect oil seal. Match scratch mark on cover and case, and cover eccentricity with case eccentricity before fastening cover securely to case with four screws. Wire cover screws with lock wire. Tap or press with brass bar on ported end of drive shaft to bottom front ball bearing in cover bore. Be sure ported end of drive shaft and rear ball bearing are kept free of brass chips or dirt.

f. Assemble End Head Assembly (figs. 33, 50, and 128). Lay end head on nameplate surface and insert, in the order given, the two small back-up springs, pistons, and tumblers into their respective small holes. Insert, in the order given, the large back-up spring, piston, and tumbler into the large hole. Be sure the hold-down tumblers fit into the end of their respective back-up pistons. Insert the two equalizer pistons into their respective holes in flat valve with tapped ends outward. Slip flat valve, with crescents on top, over retaining pins in end head. Be sure two small holes in flat valve fit over two small tumbers. Depress flat valve sufficiently with thumb (fig. 33) to insert the two lock pins.

g. Assemble End Head Assembly to Case (figs. 3 and 128). Place gasket on end head assembly and set end head on case. See figure 3 for position of end head in relation to case drain fitting. Place gaskets on screws and fasten end head securely to case with four screws. Wire end head screws with lock wire.

h. Assemble Coupling to Drive Shaft (figs. 3 and 21). Set Woodruff key in motor shaft keyway. Slide coupling onto shaft. Lock coupling to shaft with cotter pin.

36. Test Before Installation

Refer to paragraphs 63 and 64.

Section V. REBUILD OF TRAVERSING GEAR MECHANISM

37. Disassembly

a. GENERAL. Cleanliness is important in the disassembly and inspection of the traversing gear mechanism. Make certain the work bench or rebuild stand (fig. 62) is free from foreign matter. Place a large piece of heavy wrapping paper on work bench to further insure cleanliness. This precaution will protect the highly finished working parts and reduce chances of losing small parts. During disassembly, avoid striking the highly finished surfaces together. After disassembly, and before inspection, wash all parts thoroughly in dry-cleaning solvent or volatile mineral spirits paint thinner and blow them off with compressed air.

Caution: Wash individual parts only. Do not wash subassemblies or complete assemblies because it is impractical to remove all cleaning fluid and impossible to properly repack assemblies with grease.

Before assembly, pack all bearings and coat all gears with Ordnance Department lubricating grease; coat seals with a mixture containing 20 percent colloidal graphite and 80 percent light lubricating oil. Cleanliness, plus care in handling of working parts, will reduce malfunctioning and increase the life of the traversing gear mechanism.

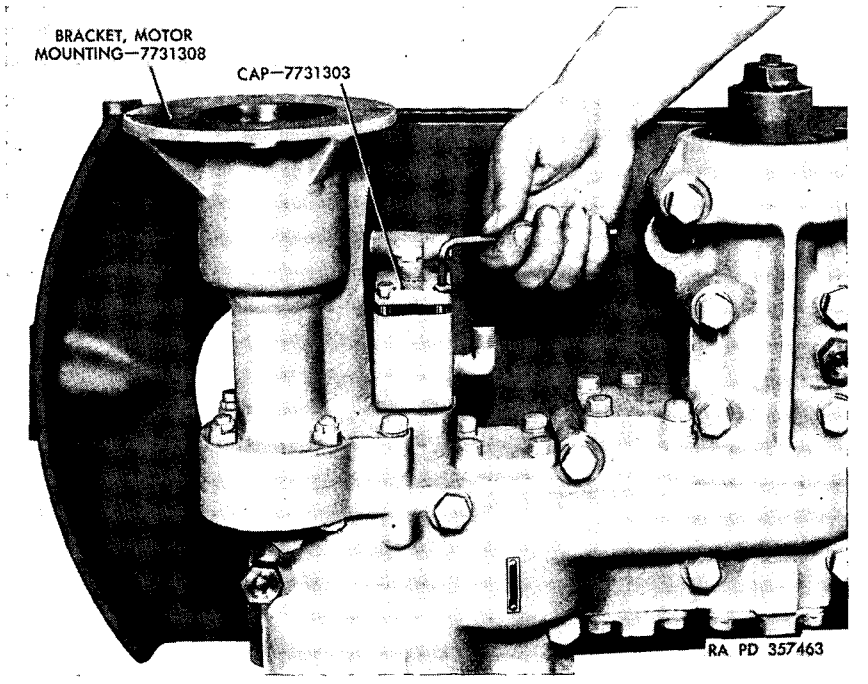


Figure 56. Removing or installing of hydraulic locking cylinder.

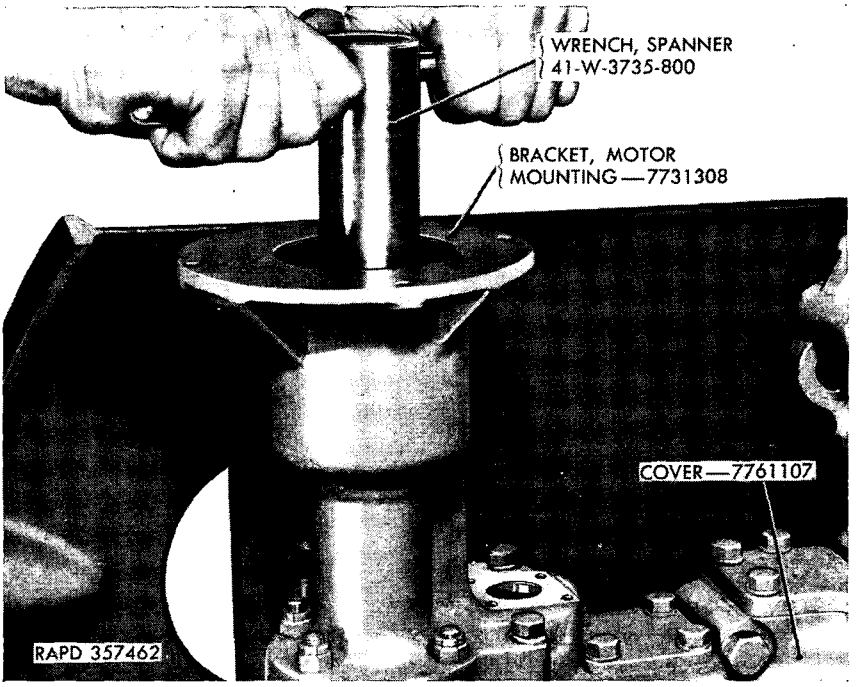


Figure 57. Removing or installing of bearing lock nut on drive gear shaft.

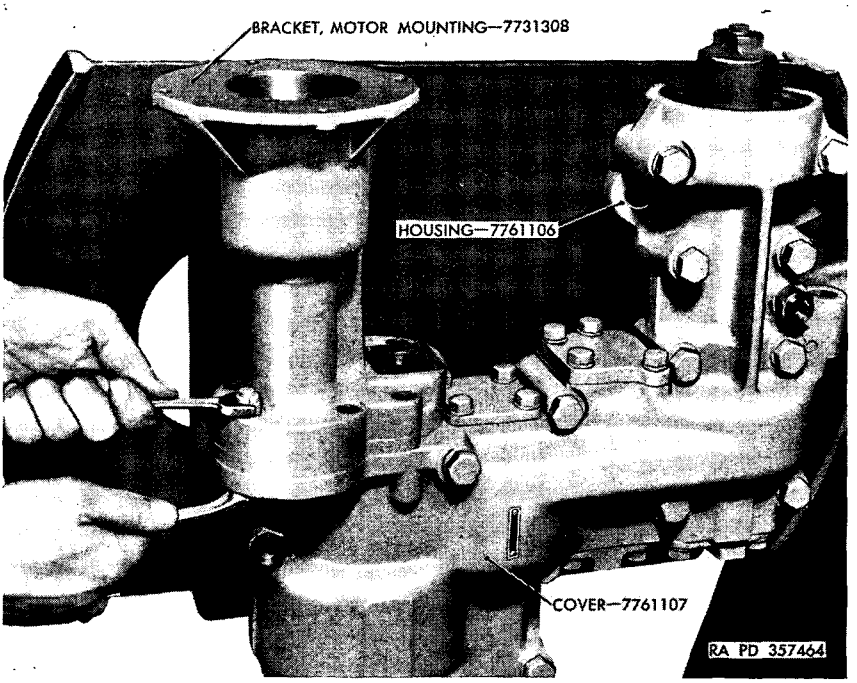


Figure 58. Removing or installing of hydraulic motor mounting bracket and drive gear assembly.

b. Remove Gunner's Shifter Control Assembly and Hydraulic Motor Assembly. Refer to paragraphs 22 and 24.

c. Remove Hydraulic Locking Cylinder. Turn tee in hydraulic locking cylinder cap one-eighth turn counterclockwise and remove four screws, lock washers, cap, packing, and spring (fig. 56). Lift off cylinder assembly and plunger.

d. Remove Hydraulic Motor Mounting Bracket and Drive Gear Assembly (figs. 57 and 58).

(1) Remove hydraulic locking cylinder (*c* above).

(2) Tap Woodruff key out of drive gear shaft. Straighten ear of bearing lock washer. Remove nut with spanner wrench (41–W–3735–800) (fig. 57). Remove lock washer. Drive out straight dowel pin from bracket and housing. Remove dowel bolt, three screws, two bolts, and lock washers. Lift off motor mounting bracket with drive gear assembly from traversing gear housing and cover.

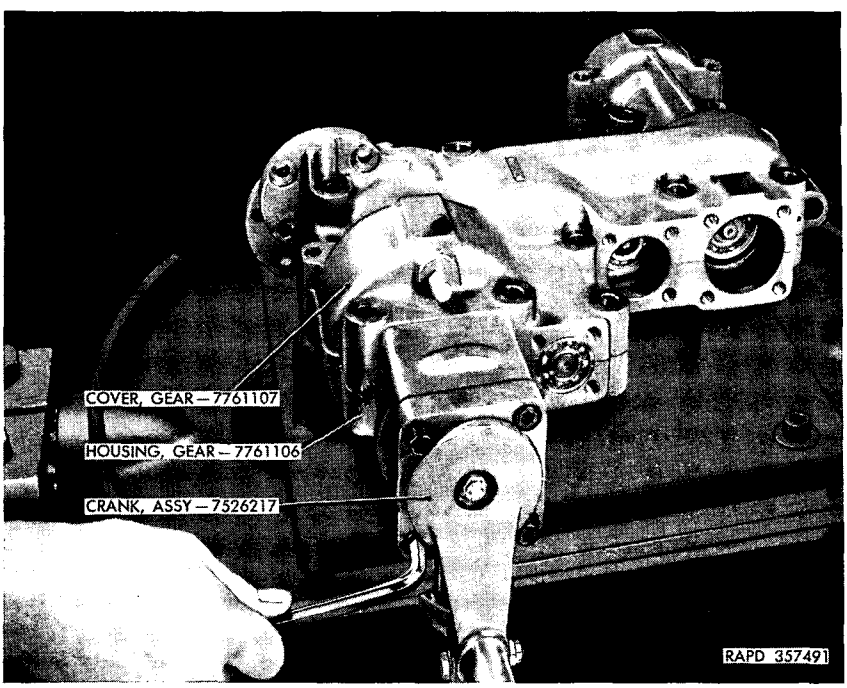


Figure 59. Removing hand crank and no-back mechanism assemblies.

e. Remove Hand Crank and No-Back Mechanism Assemblies. Remove four screws from hand crank housing (fig. 59). Lift off hand crank and no-back mechanism assemblies.

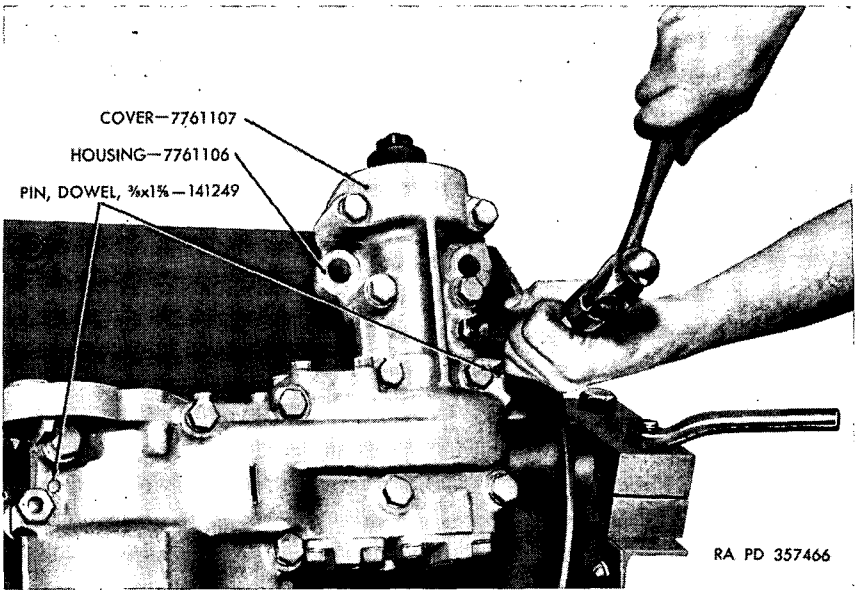


Figure 60. Removing dowels from gear housing and cover.

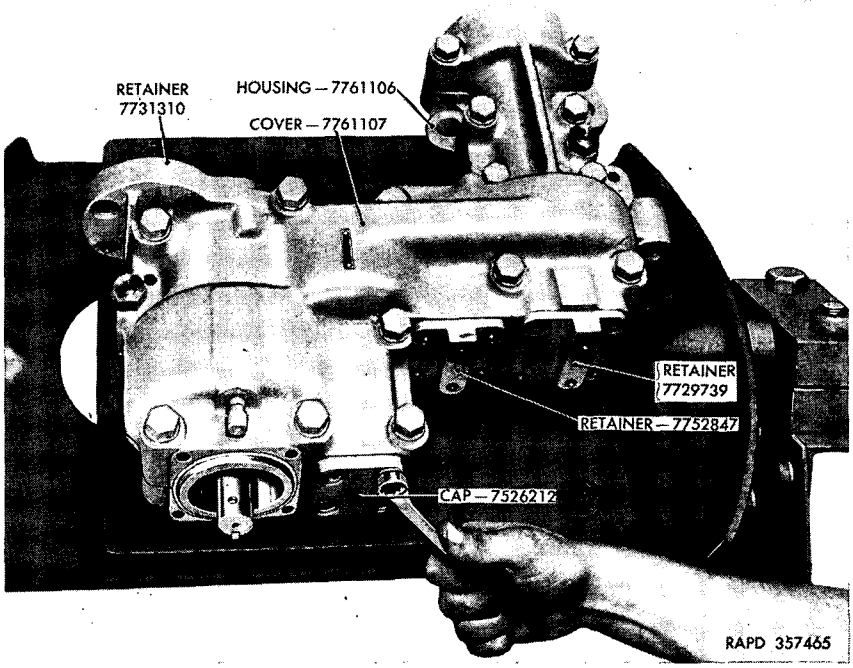


Figure 61. Removing or installing retainers and caps.

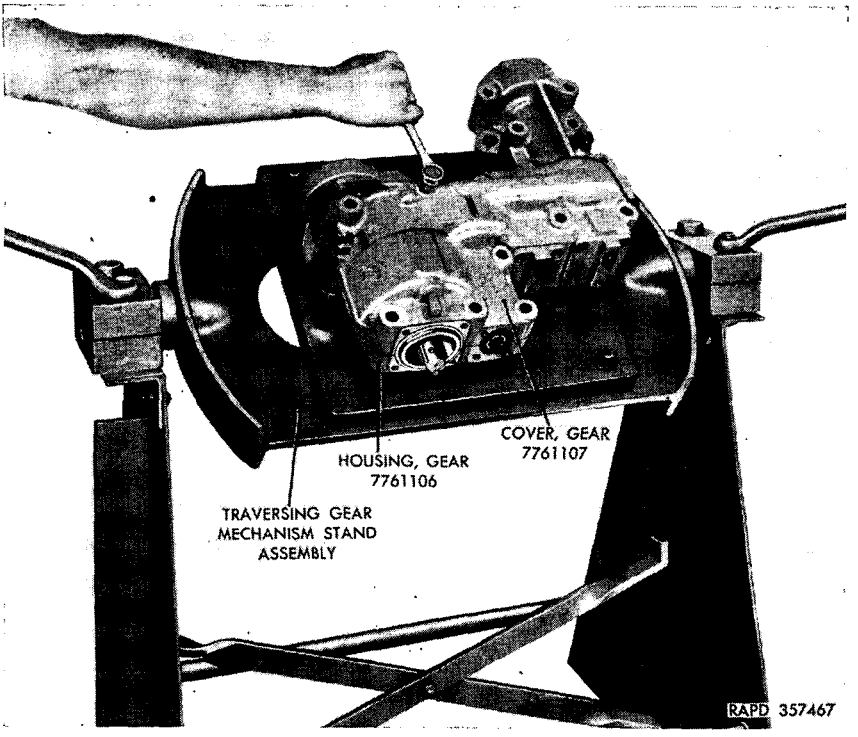


Figure 62. Removing gear cover from gear housing.

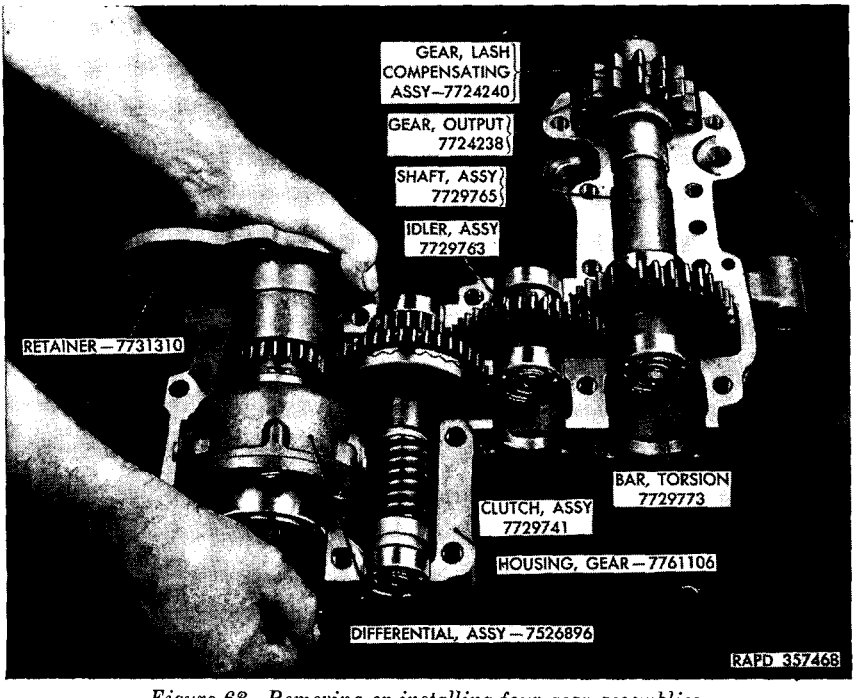


Figure 63. Removing or installing four gear assemblies.

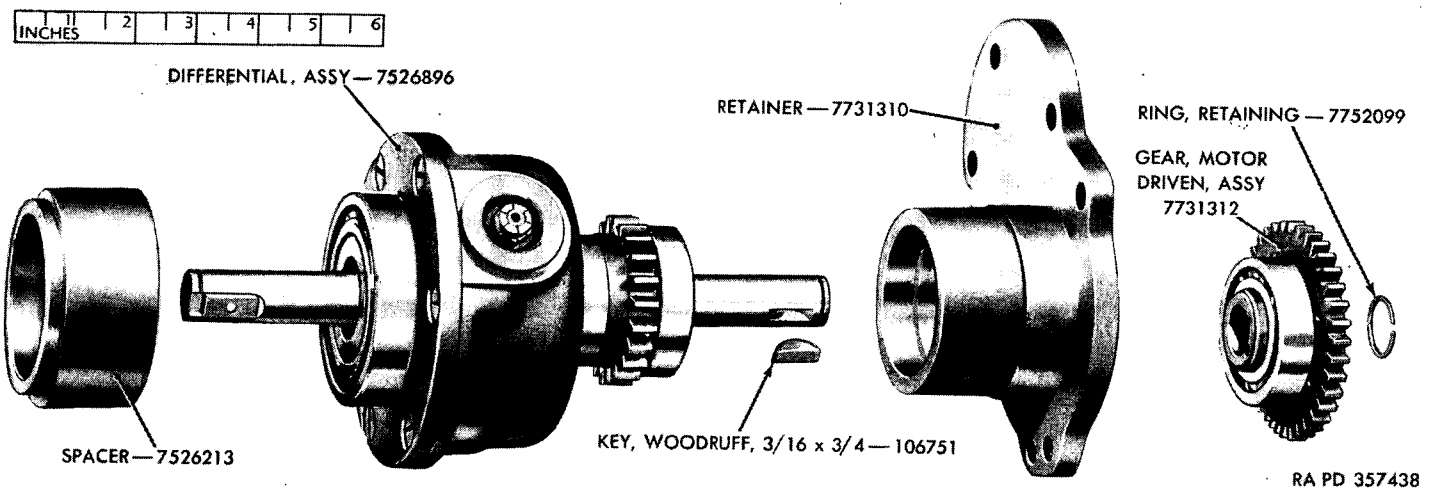


Figure 64. Differential and driven gear assemblies and retainer.

f. Remove Dowels, Retainers, Caps, Cover, and Gear Assemblies From Gear Housing (figs. 60 through 63). Drive out two dowel pins (fig. 60). Remove 20 screws and lock washers from retainers and caps (fig. 61). Remove 15 screws and lock washers from cover (fig. 62). Lift cover off housing. Lift out four gear assemblies and place them on a clean bench (fig. 63).

Note. Handle parts carefully. Avoid bumping them against each other, or with tools, to preclude nicking and/or marring gears, bearings, and other finished surfaces.

g. Disassemble Differential Assembly (figs. 23, 24, and 64 through 73).

(1) With a thin chisel, drive back metal staked over in screw slots. Mark cover, carrier, and each screw with center-punch so each screw is returned to same hole in differential cover and carrier. Remove six screws, and lift off cover and hand crank shaft assembly. Note amount of shims, if any, between cover and carrier.

(2) Remove retaining ring from differential hand crank shaft with snap ring pliers (41–P–1992–27) (fig. 66). Lift differential gear off of hand crank shaft. If gear is tight on shaft, lift differential cover off shaft bearing and press gear off shaft the short way. Tap out Woodruff key. Place cover on press and force shaft out of bearing (fig. 67), or lift differential cover off shaft bearing and remove bearing from shaft with puller. Press bearing off differential cover using two ⅛-inch pins (fig. 68).

(3) Remove one nut from pinion shaft (fig. 69), place center-punch mark on flat of carrier opposite the side where nut was removed, and pull pinion shaft out part way. Remove bearing cap, shims, thrust bearing, and one pinion assembly. Tie these parts together. Pull out nut, shaft, cap, shims, and thrust bearing. Lift out other pinion assembly. Press needle bearing out of pinion with handle (7082196) (fig. 70).

(4) Remove retaining ring from input end of differential motor shaft with snap ring pliers (41–P–1992–27). Hold assembly by the retainer above a wood block, and tap on retainer end of shaft with soft hammer to remove retainer and motor gear assembly from bearing and shaft. Tap Woodruff key out of shaft.

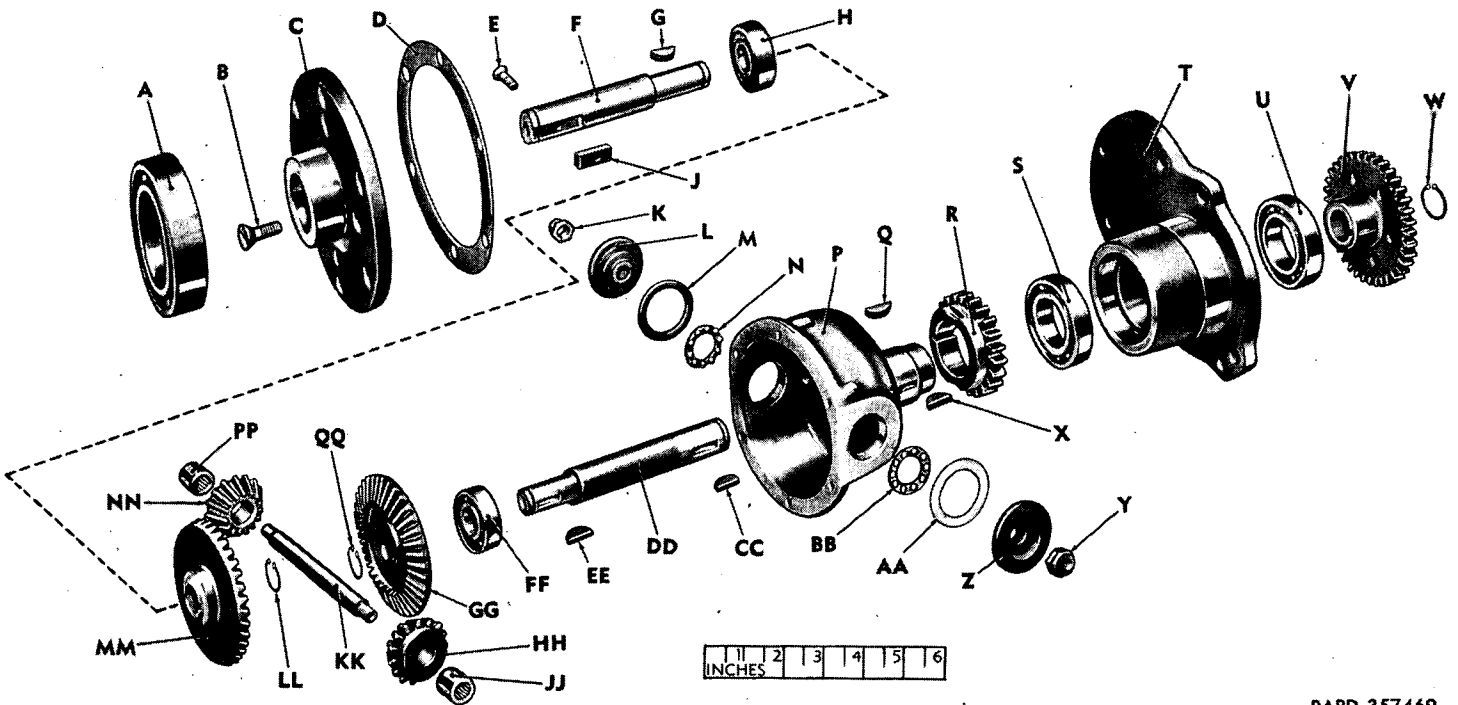


Figure 65. Differential and driven gear assembly and retainer, exploded view.

A—BEARING, DIFFERENTIAL COVER—701024.
B—SCREW, MACHINE, FL-HD, ¼-28NF X ¾—421309.
C—COVER, DIFFERENTIAL—7751988.
D—SHIM, COVER (VARIOUS THICKNESSES).
0.002—7752063.
0.005—7752064.
0.007—7752065.
E—SCREW, MACHINE, FL-HD, NO 8-32NC X ¾—100818.
F—SHAFT, HAND CRANK—7526208.
G—KEY, WOODRUFF, 5/32 X 5/8—106750.
H—BEARING. HAND CRANK—700061.
J—KEY, HAND-CRANK SHAFT—7526209.
K—NUT, LOCK, HEX, 5/16-24NF—503345.
L—CAP, THRUST, PINION—7751980.
M—SHIM, CAP (VARIOUS THICKNESSES).
0.015—7751991.
0.005—7751992.
0.002—7751993.
N—BEARING, THRUST, PINION—7752085.
P—CARRIER, DIFFERENTIAL—7729752.
Q—KEY, WOODRUFF, 3/16 X ¾—124549.
R—GEAR, CARRIER—7729755.
S—BEARING, DIFFERENTIAL CARRIER—701022.
T—RETAINER, MOTOR DRIVEN BEARING—7731310.
U—BEARING, MOTOR DRIVEN GEAR—701022.
V—GEAR, MOTOR, DRIVEN—7731309.
W—RING, RETAINING—7752099.
X—KEY, WOODRUFF, 3/16 X ¾—124549.
Y—NUT, LOCK, HEX, 5/16-24NF—503345.
Z—CAP, THRUST, PINION—7751980.
AA—SHIM, CAP (VARIOUS THICKNESSES).
0.015—7751991.
0.005—7751992.
0.002—7751993.
BB—BEARING, THRUST, PINION—7752085.
CC—KEY, WOODRUFF, 3/16 X ¾—106751.
DD—SHAFT, MOTOR, DRIVEN—7731306.
EE—KEY, WOODRUFF, 5/32 X 5/8—106750.
FF—BEARING, MOTOR DRIVEN SHAFT—700061.
GG—GEAR, DIFFERENTIAL—7751951.
HH—PINION, DIFFERENTIAL—7751949.
JJ—BEARING, PINION—709483.
KK—SHAFT, PINION—7751979.
LL—RING, RETAINING—7752084.
MM—GEAR, DIFFERENTIAL—7751951.
NN—PINION, DIFFERENTIAL—7751949.
PP—BEARING, PINION—709483.
QQ—RING, RETAINING—7752084.

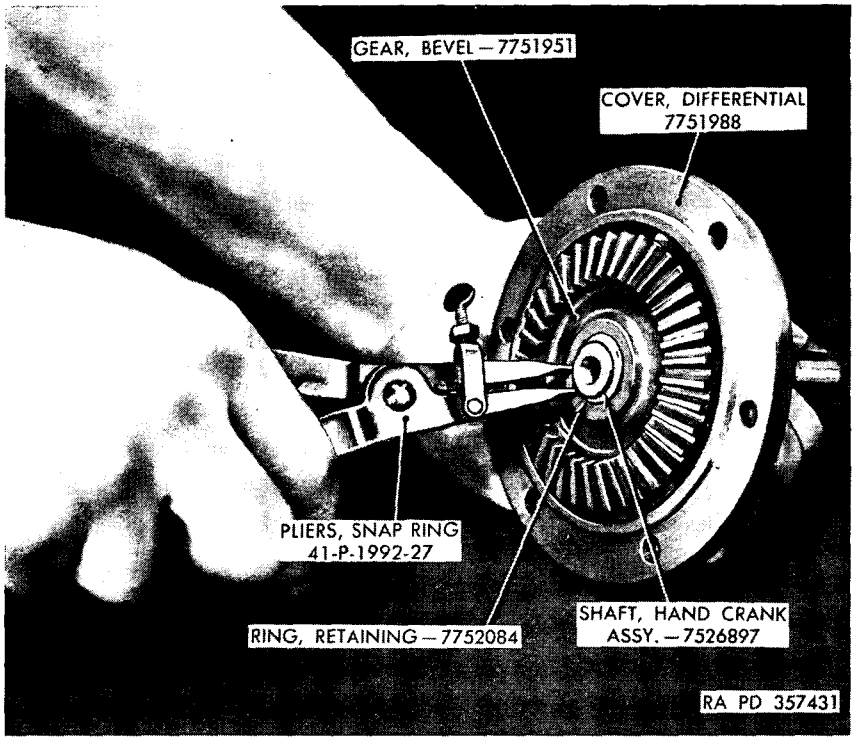


Figure 66. Removing retaining ring from hand crank shaft assembly.

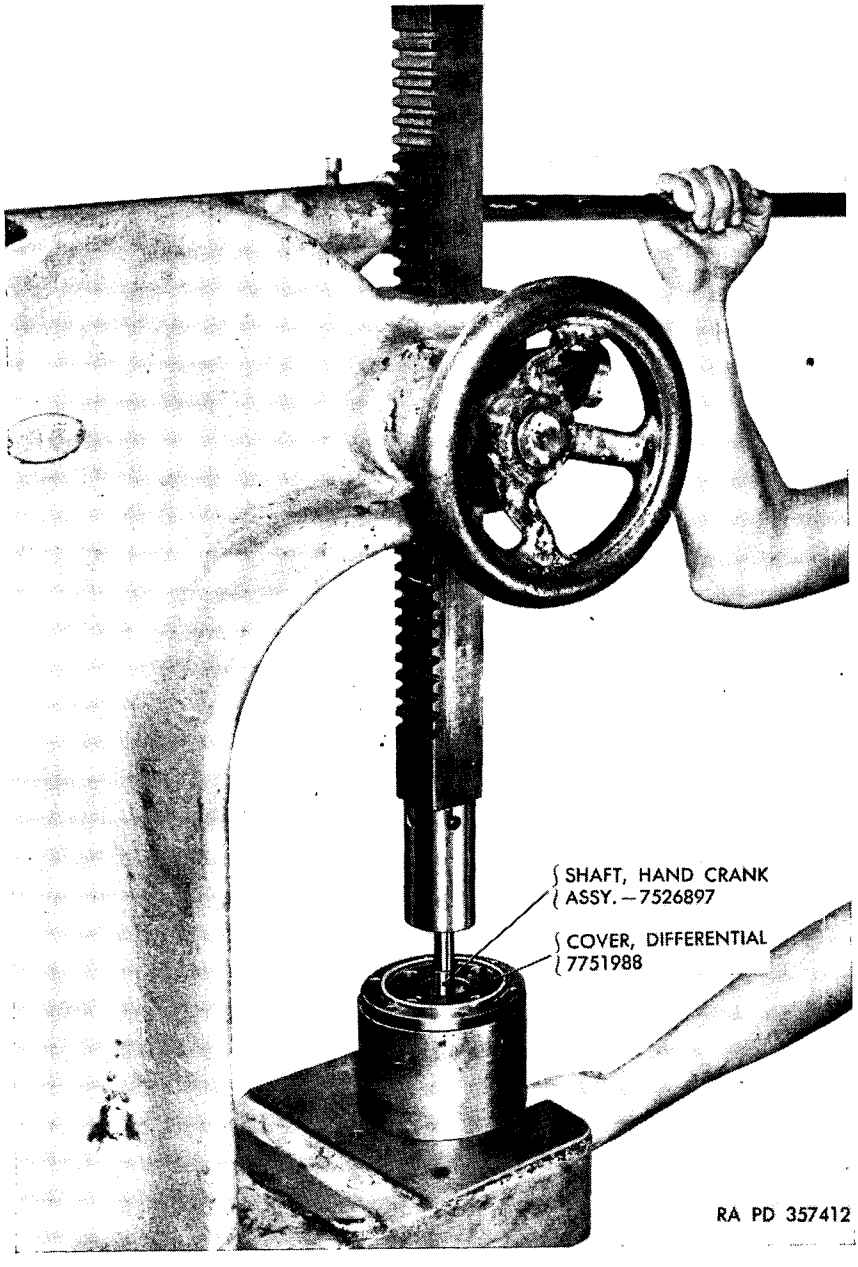


Figure 67. Pressing hand crank shaft out of differential cover bearing.

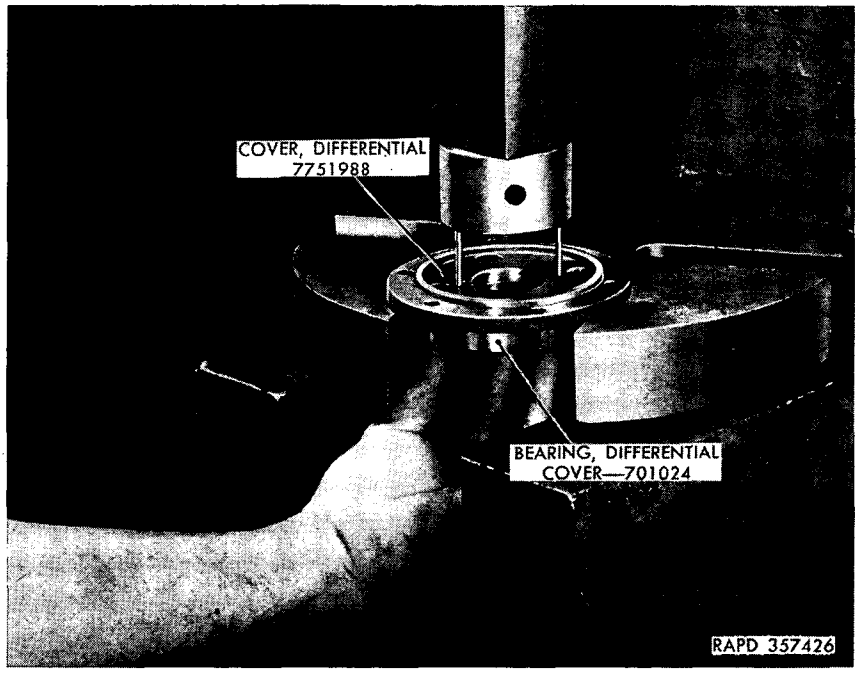


Figure 68. Pressing bearing off differential cover.

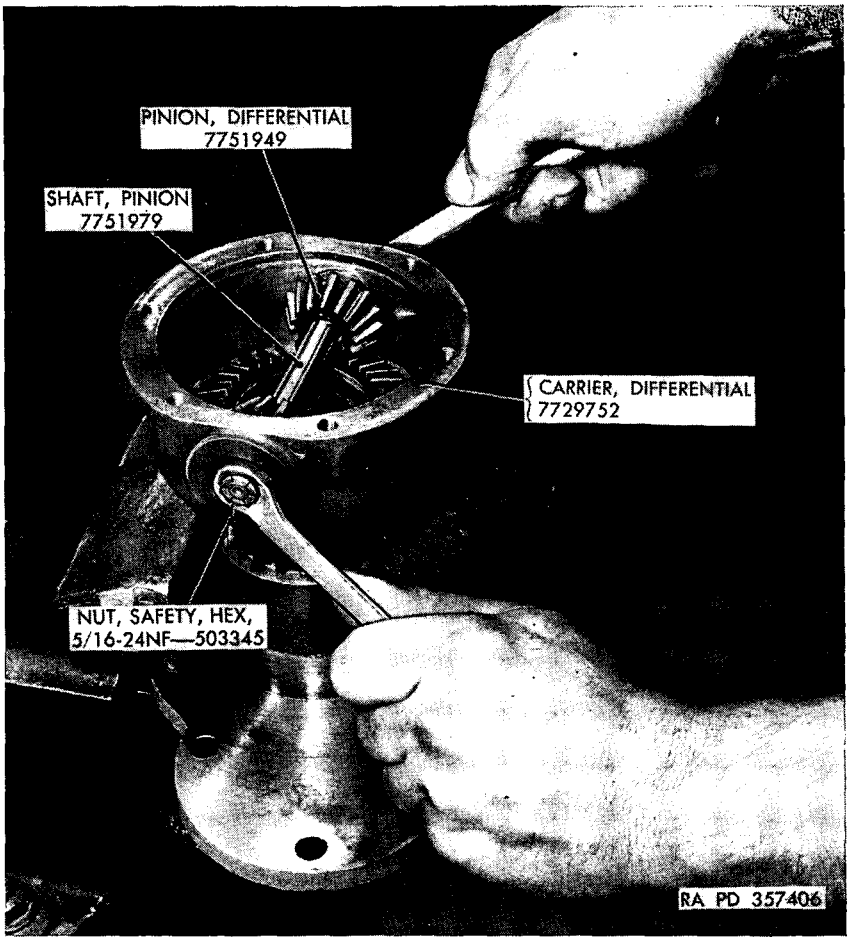


Figure 69. Removing nut from differential pinion shaft.

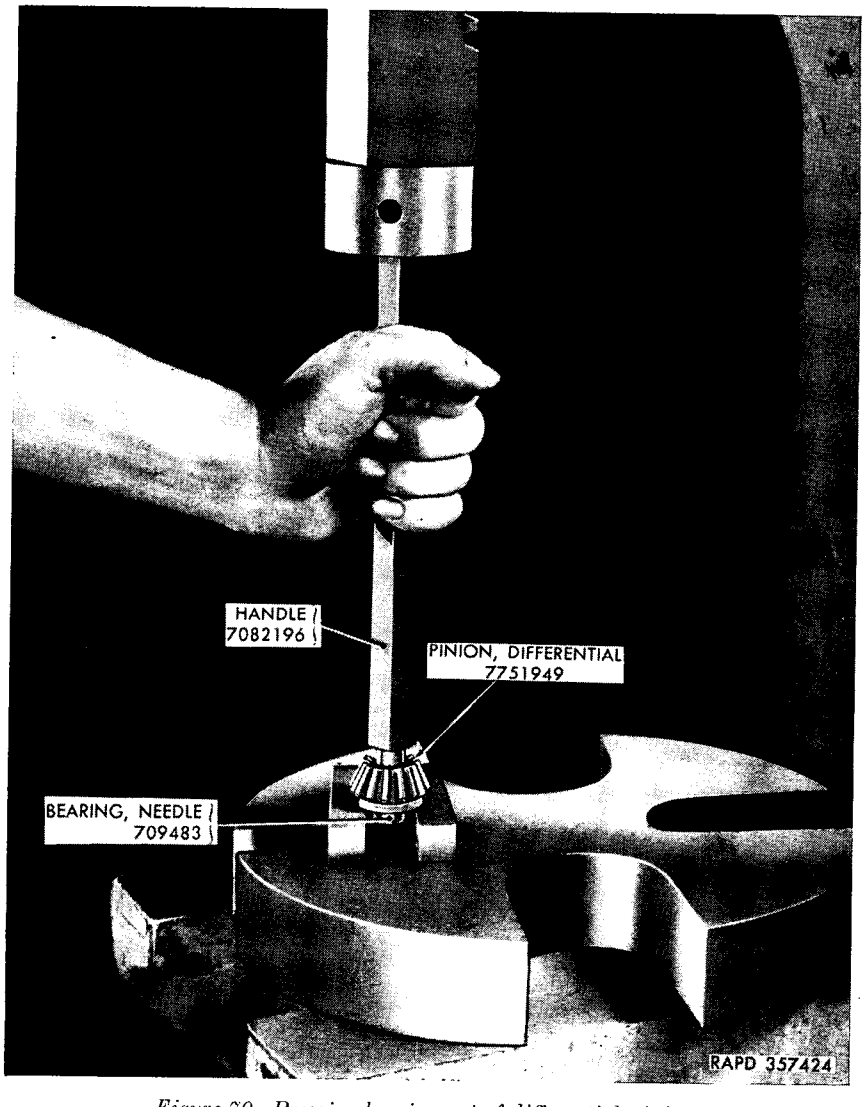


Figure 70. Pressing bearing out of differential pinion.

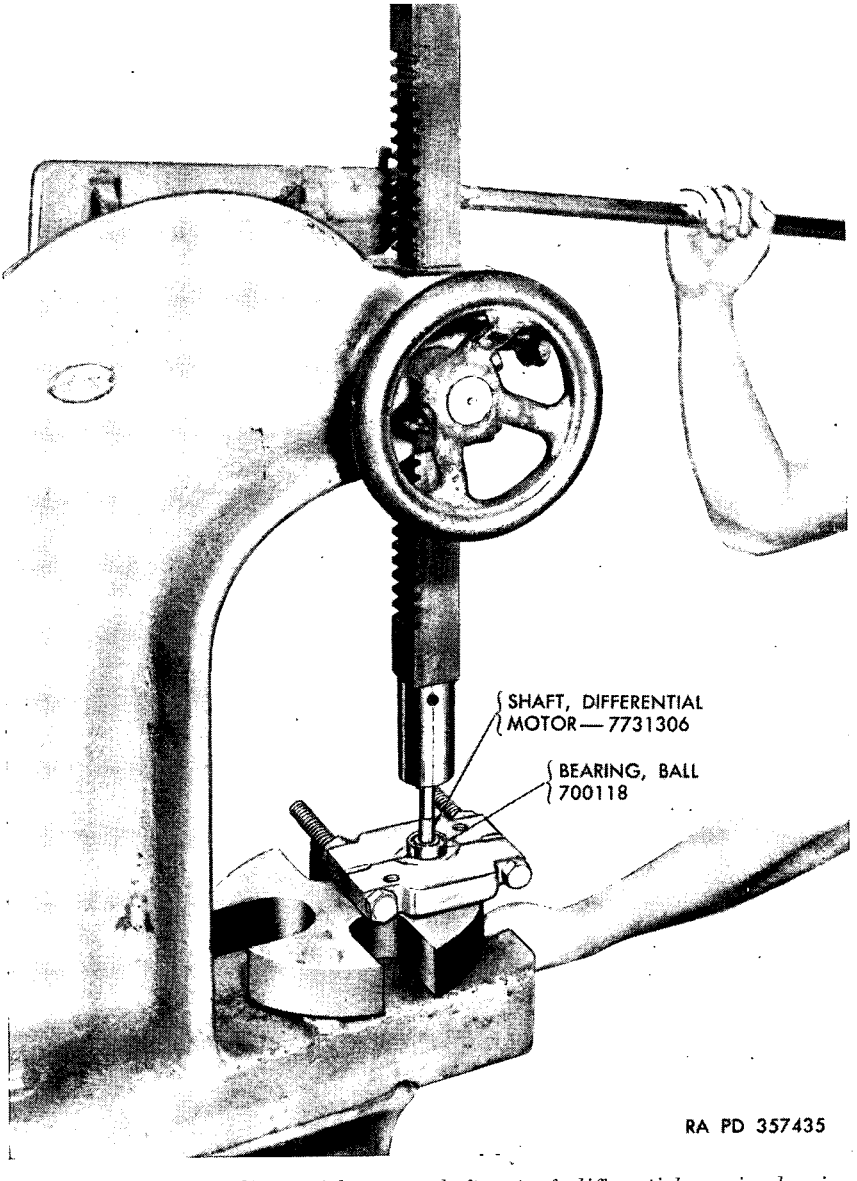


Figure 71. Pressing differential motor shaft out of differential carrier bearing.

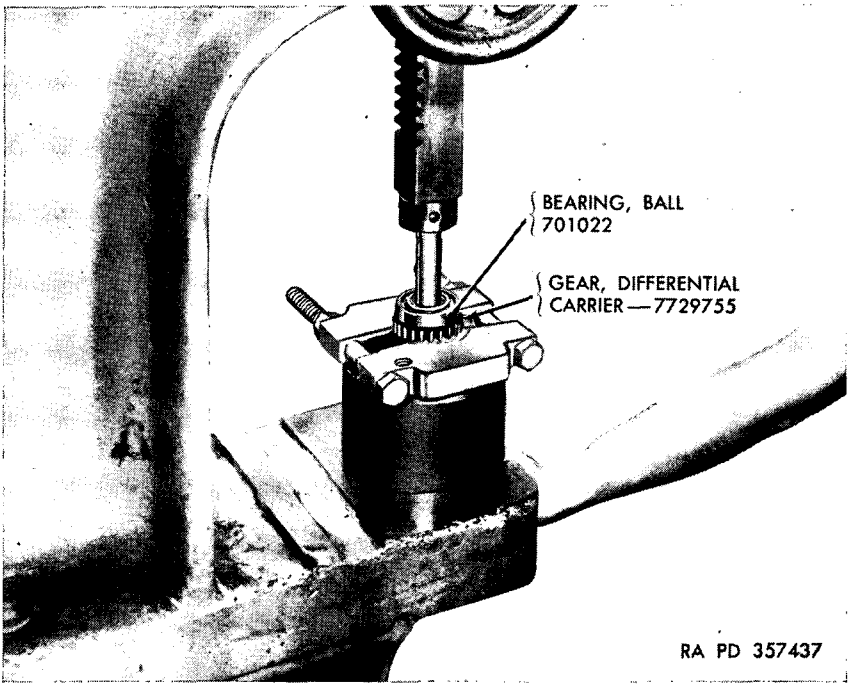


Figure 72. Pressing differential carrier out of carrier gear and bearing.

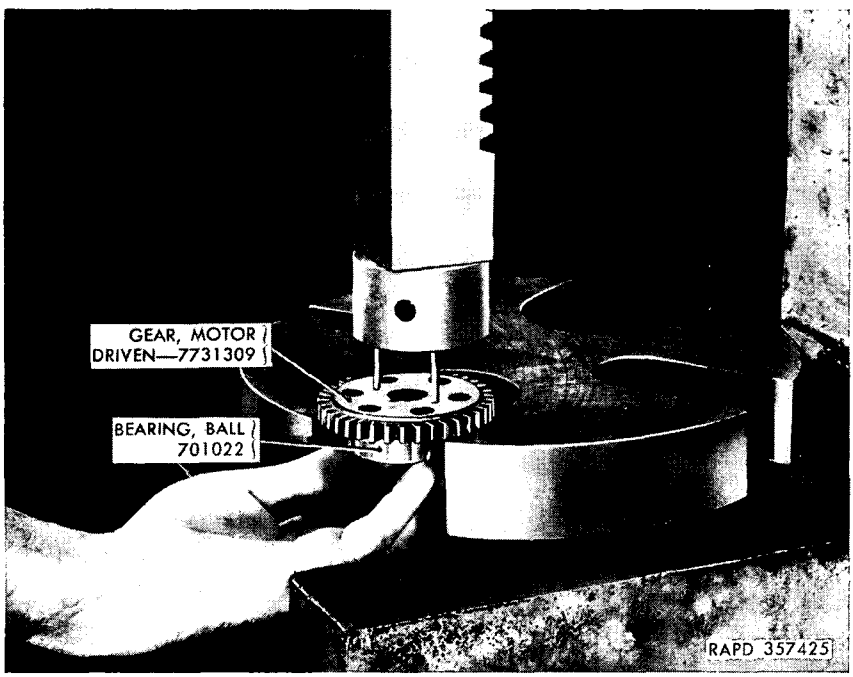


Figure 73. Pressing bearing off motor driven gear.

(5) Pull shaft assembly out of differential carrier. Remove retaining ring from shaft with snap ring pliers (41–P–1992–27) (fig. 66). Pull gear off shaft and tap Woodruff key out of shaft. Press shaft out of differential bearing (fig. 71). Press differential carrier out of carrier gear and bearing (fig. 72) and tap Woodruff keys out of carrier. Press bearing off motor driven gear with two ⅛-inch diameter pins and arbor press (fig. 73).

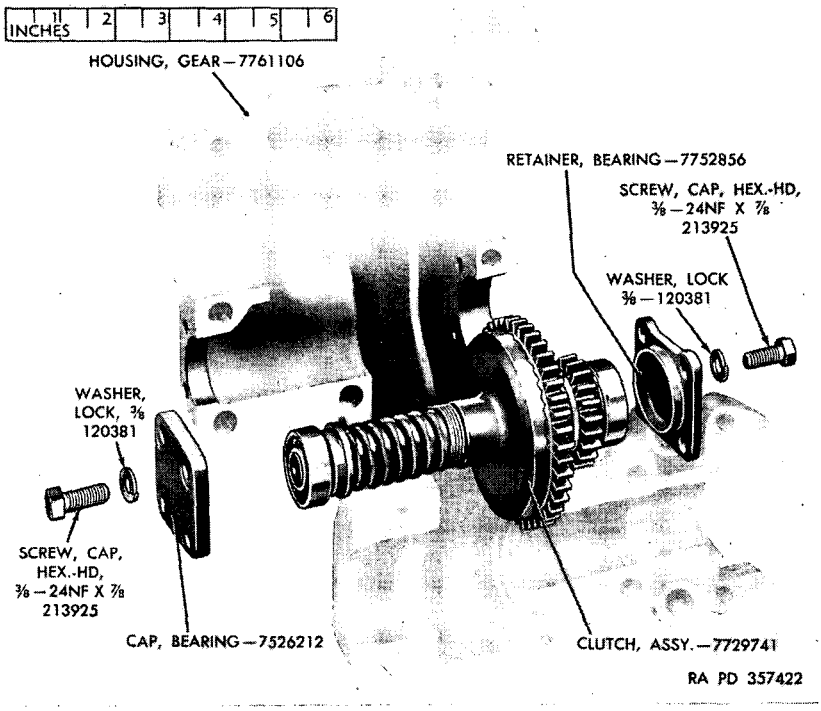


Figure 74. Clutch gear and shaft assembly.

h. Disassemble Clutch Assembly (figs. 74, 75, and 76).

(1) Press clutch shaft assembly out of bearings using bearing puller or arbor press (fig. 76).

(2) Set clutch assembly in press and place adapter (7082911) over clutch spring retainer to rest on washer, with adapter and

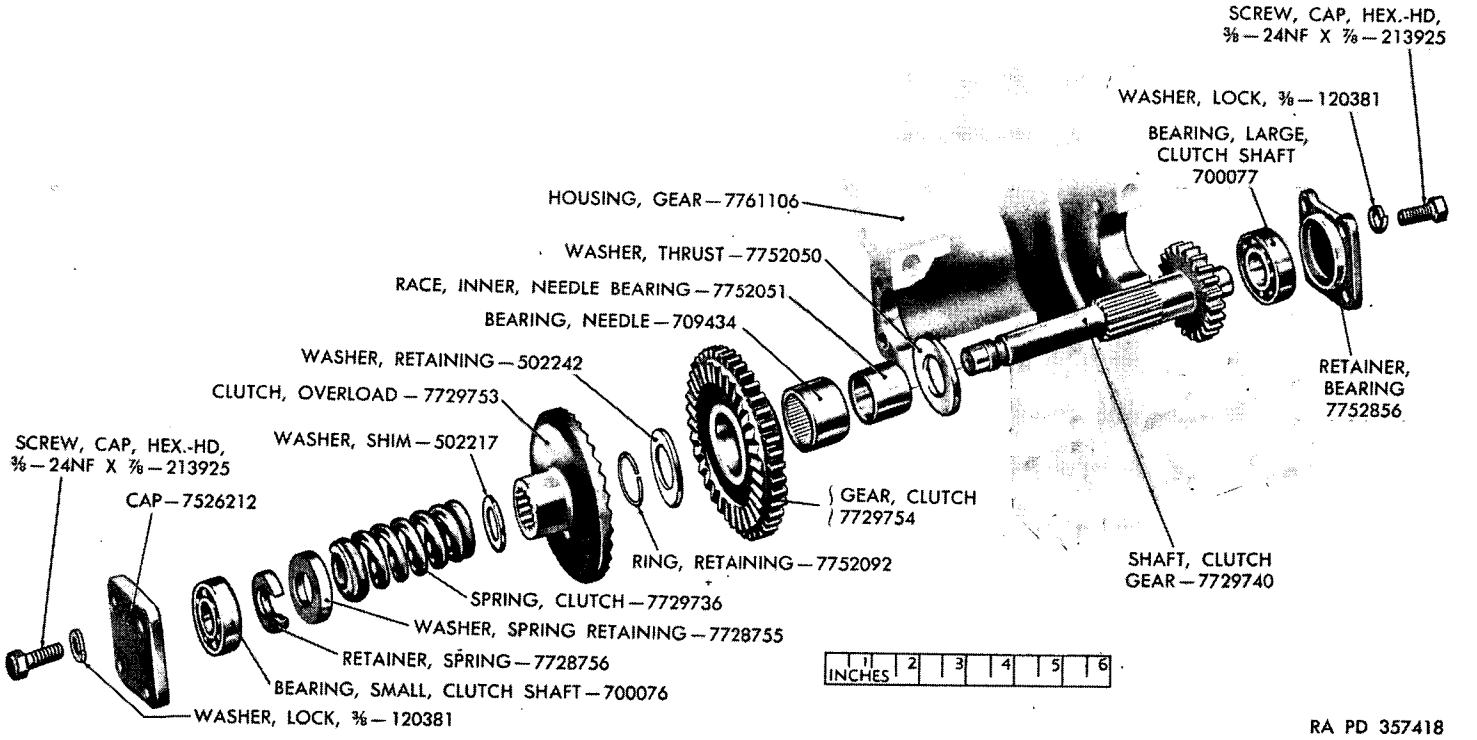


Figure 75. Clutch gear and shaft assembly, exploded view.

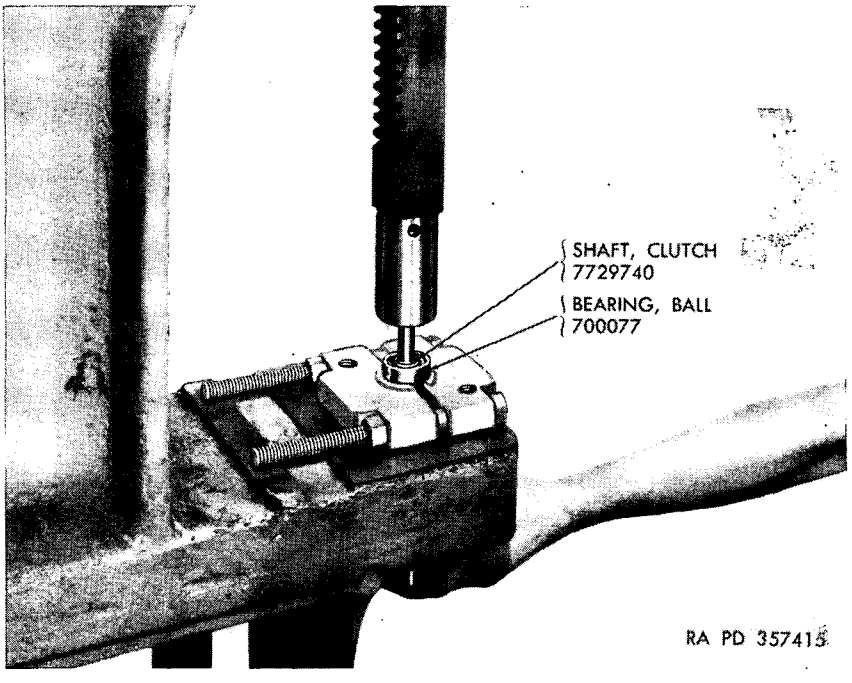


Figure 76. Pressing clutch shaft out of bearing.

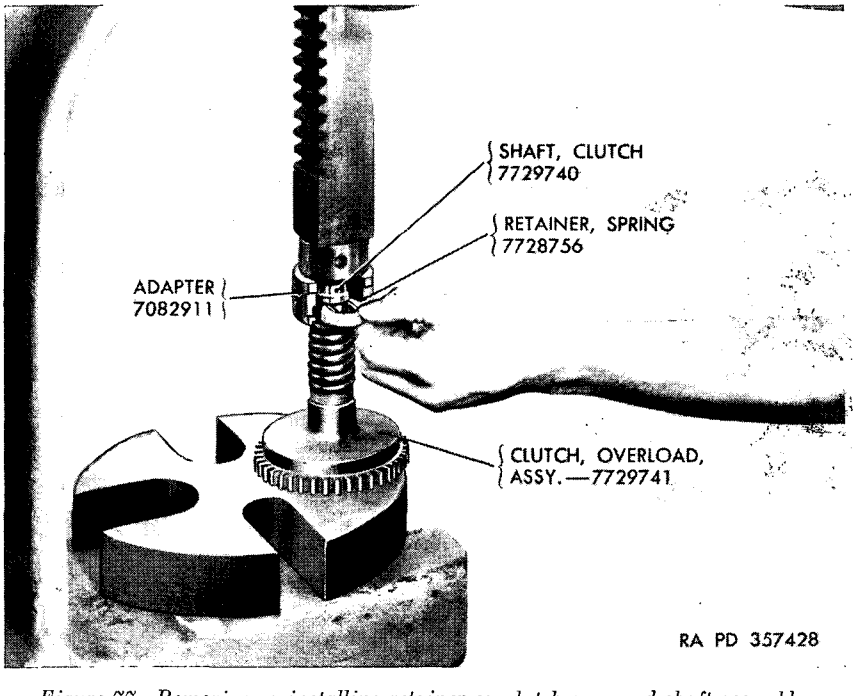


Figure 77. Removing or installing retainer on clutch gear and shaft assembly.

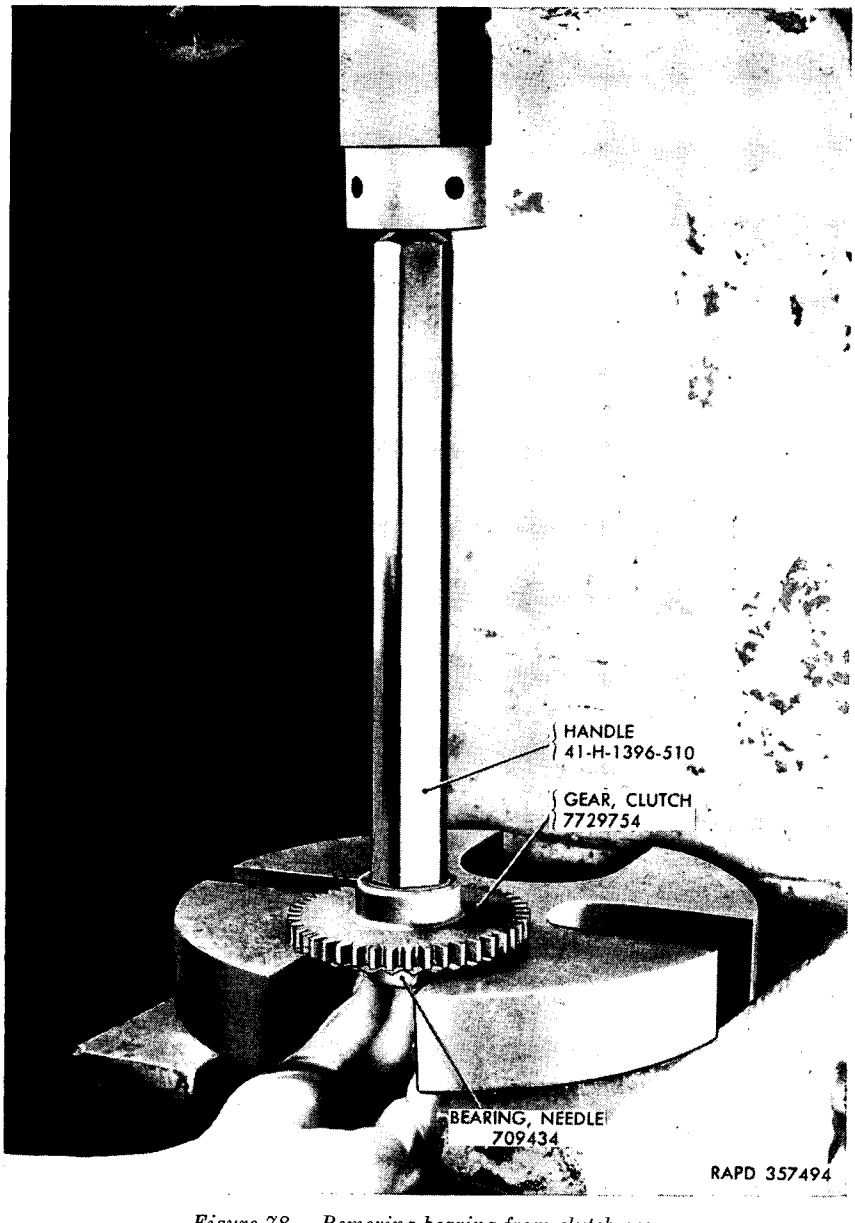


Figure 78. Removing bearing from clutch gear.

retainer "U" shaped openings facing opposite directions. Press down on adapter and pull out retainer (fig. 77).

Warning: The spring exerts 750-pound force when compressed far enough to remove the retainer and can cause serious injury should adapter slip.

Note. The retainer also can be removed by means of adapter (7082911) and a puller instead of the press.

Release spring. Remove washer, spring, shim washers, and clutch.

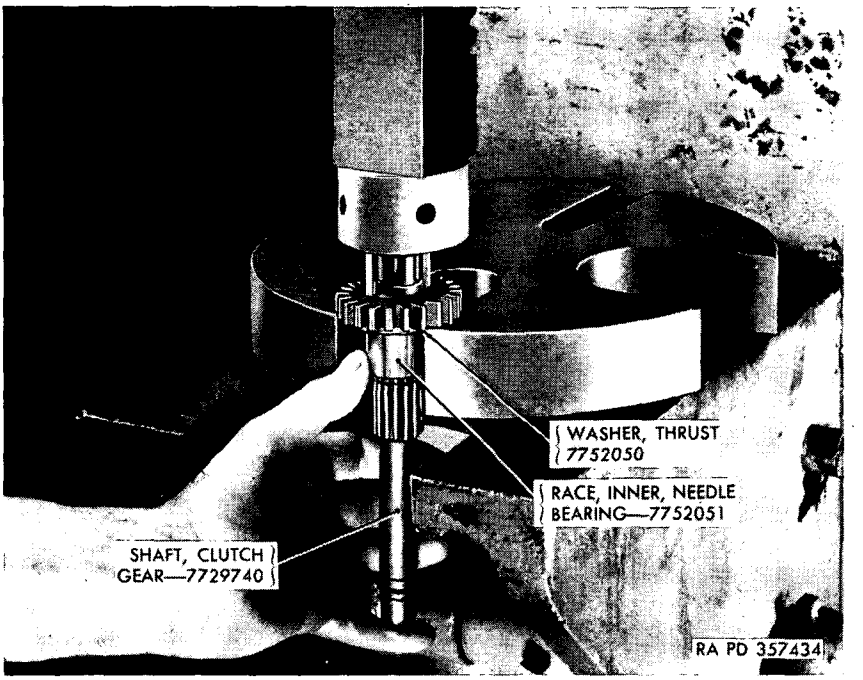


Figure 79. Removing needle bearing shell from clutch shaft.

(3) Remove retaining ring from clutch shaft with snap ring pliers (7081641). Remove washer and clutch gear. Press bearing out of clutch gear with handle (41–H–1396–510) (fig. 78). Press needle bearing inner race and thrust washer off clutch shaft using two ⅛-inch diameter pins and arbor press (fig. 79.)

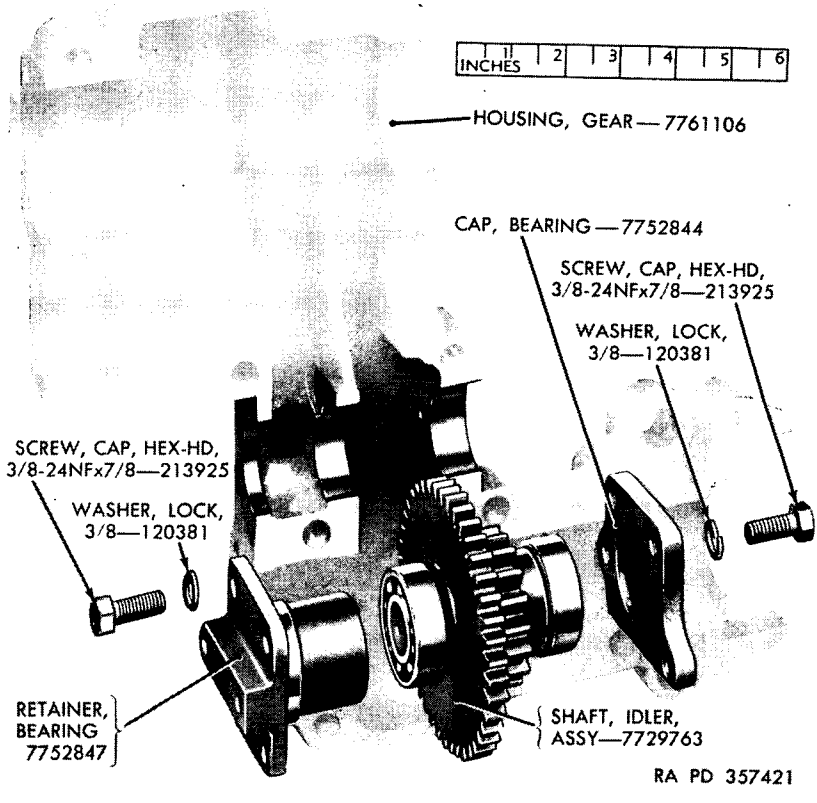


Figure 80. Idler gear and shaft assembly.

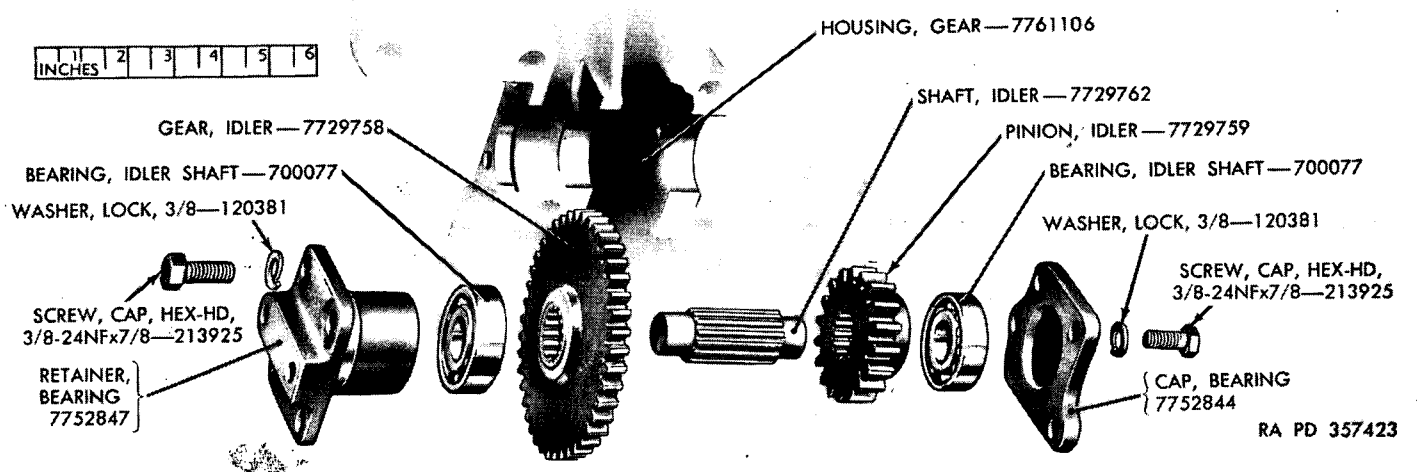


Figure 81. Idler gear and shaft assembly, exploded view.

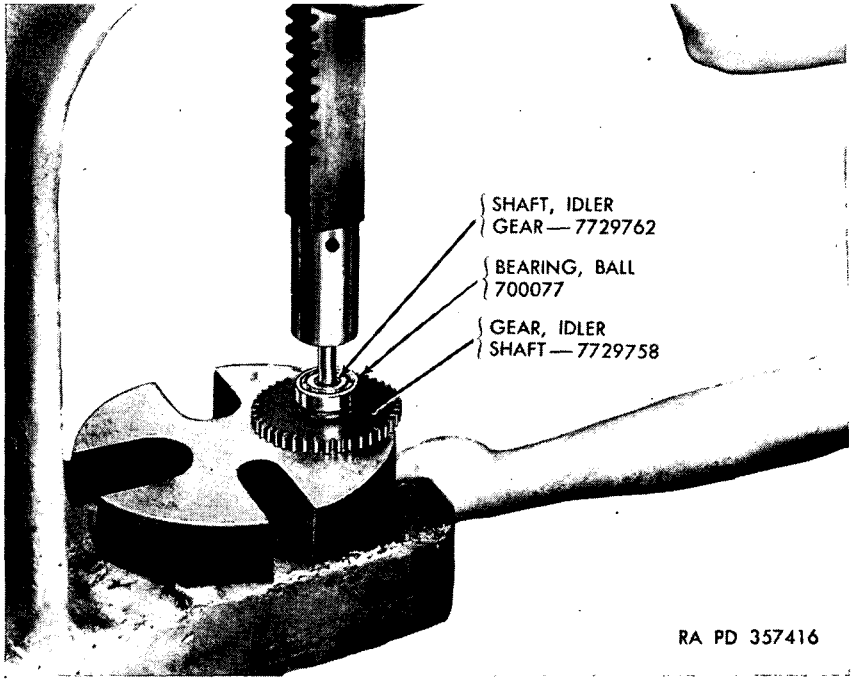


Figure 82. Pressing idler gear shaft out of idler gear and bearing.

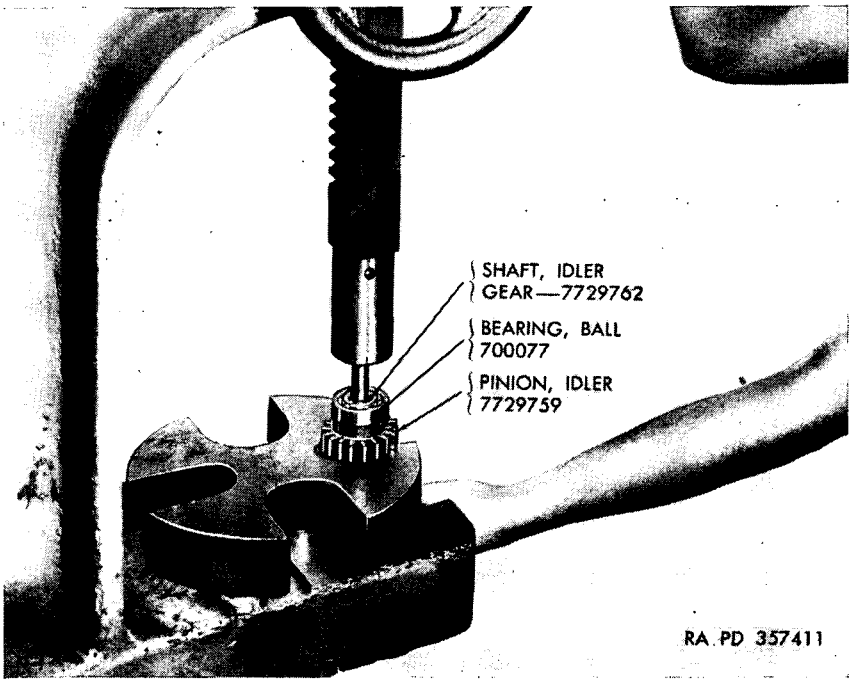


Figure 83. Pressing idler gear shaft out of idler pinion and bearing.

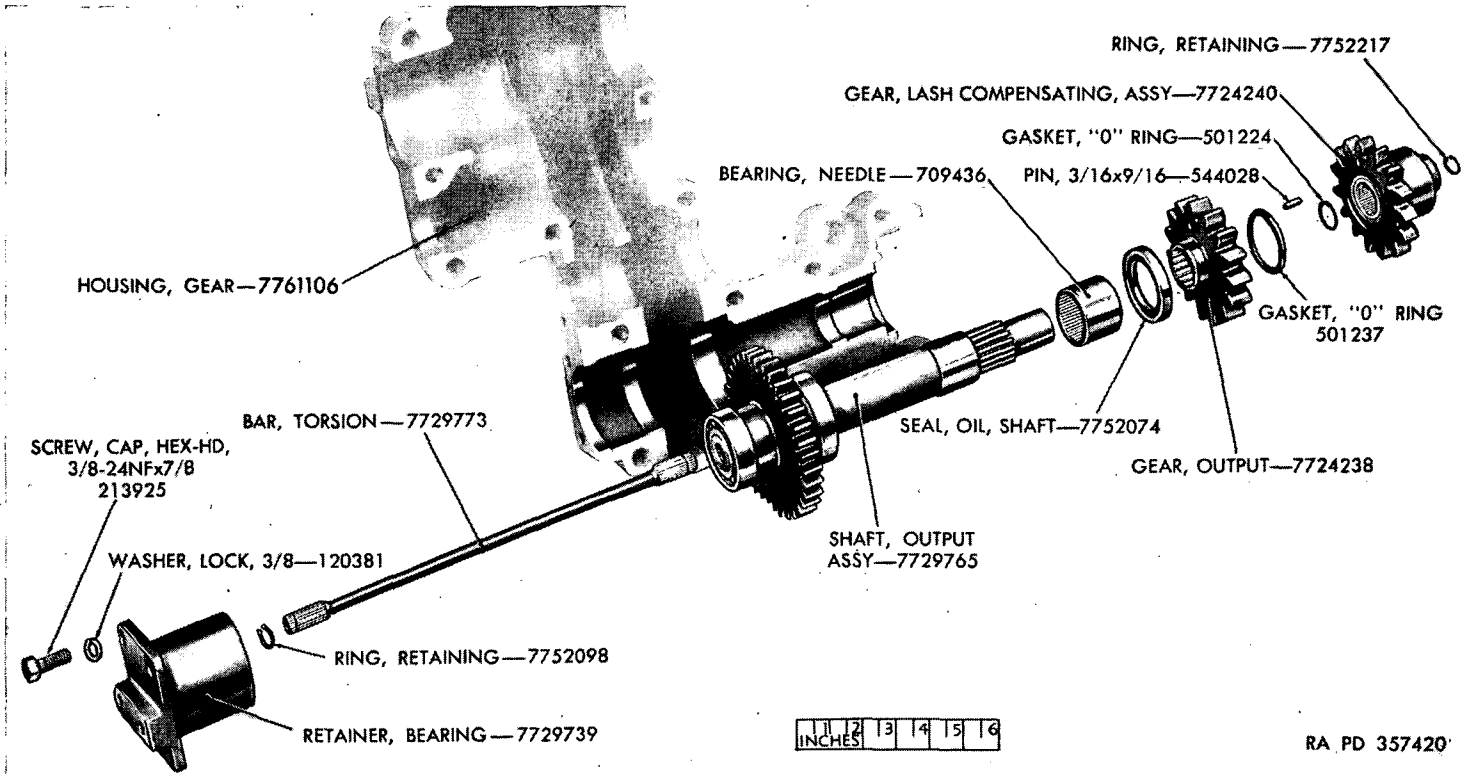


Figure 84. Output shaft assembly.

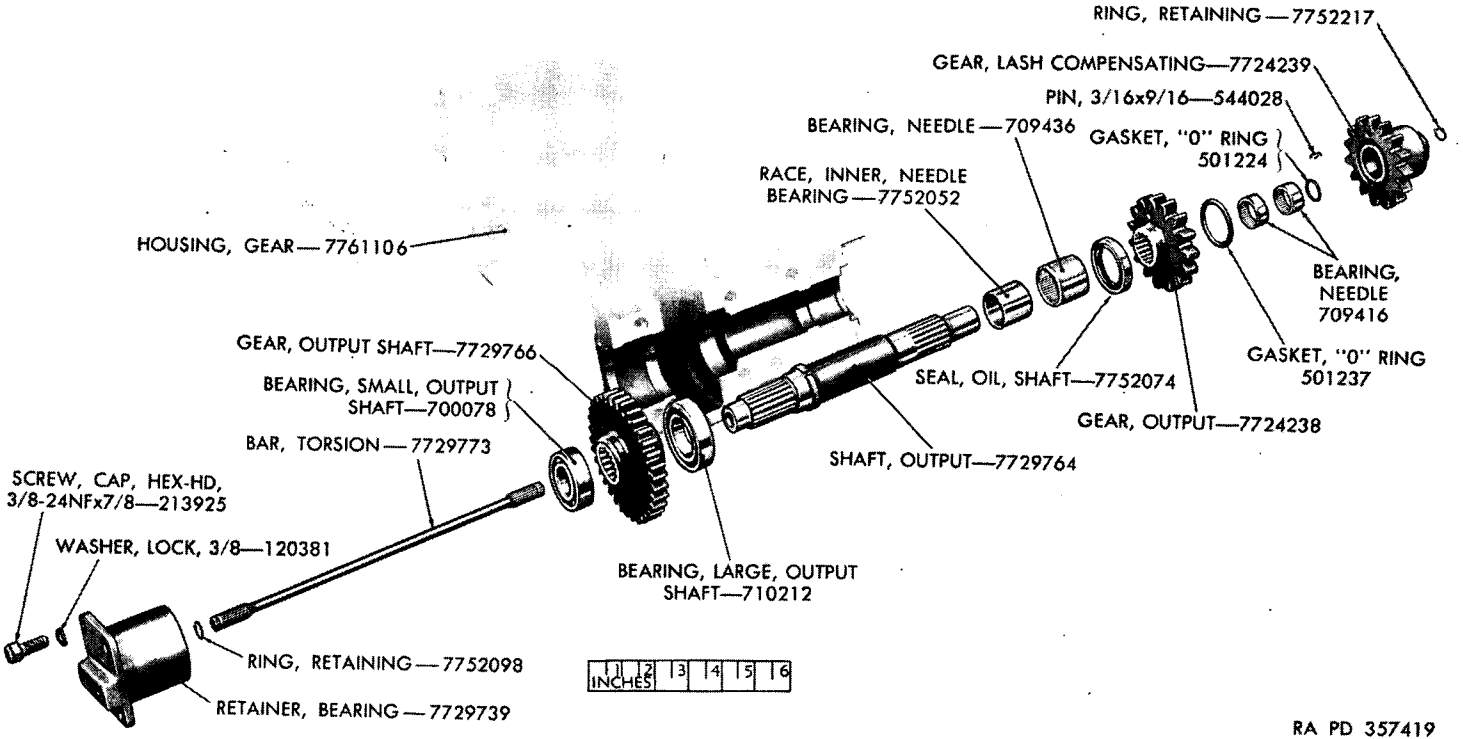


Figure 85. Output shaft assembly, exploded views.

i. Disassemble Idler Gear and Shaft Assembly (figs. 80 through 83). Inspect both bearings, pinion, and gear before disassembly (par. 39). Remove shaft out of idler shaft gear and one bearing with puller or use arbor press (fig. 82). Remove shaft out of pinion and other bearing with puller, or use arbor press (fig. 83).

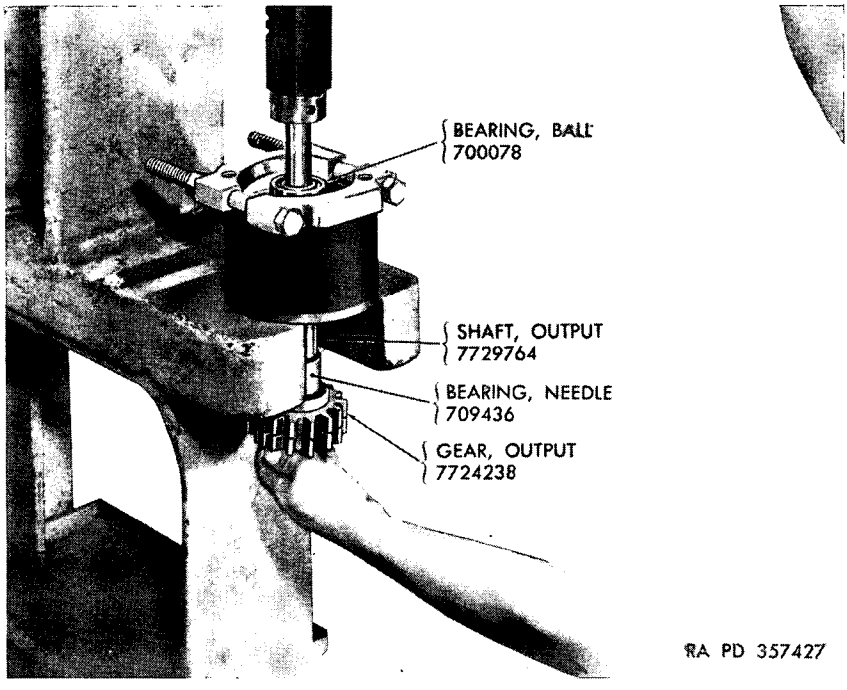


Figure 86. Pressing output shaft out of output gear bearing.

j. Disassemble Output Shaft Assembly (figs. 84 through 88).

(1) Press output shaft out of bearing (fig. 86) and press output shaft out of output shaft gear (fig. 87), or use puller to remove both bearing and gear from shaft. Press output shaft out of bearing (fig. 88), or use puller to remove bearing from shaft.

Note. Be sure remover rests on end of output shaft and not on torsion-bar retaining ring

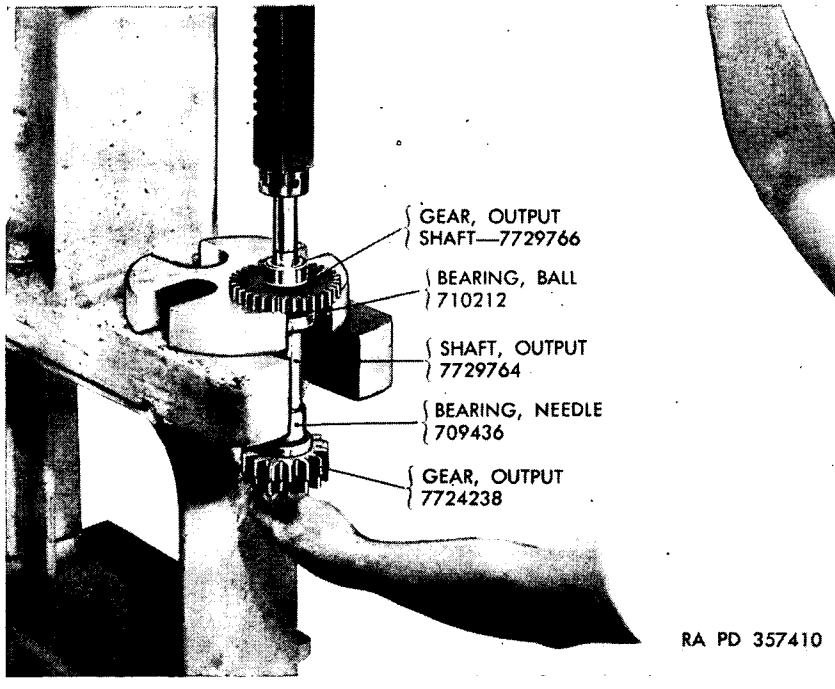


Figure 87. Pressing output shaft out of output shaft gear.

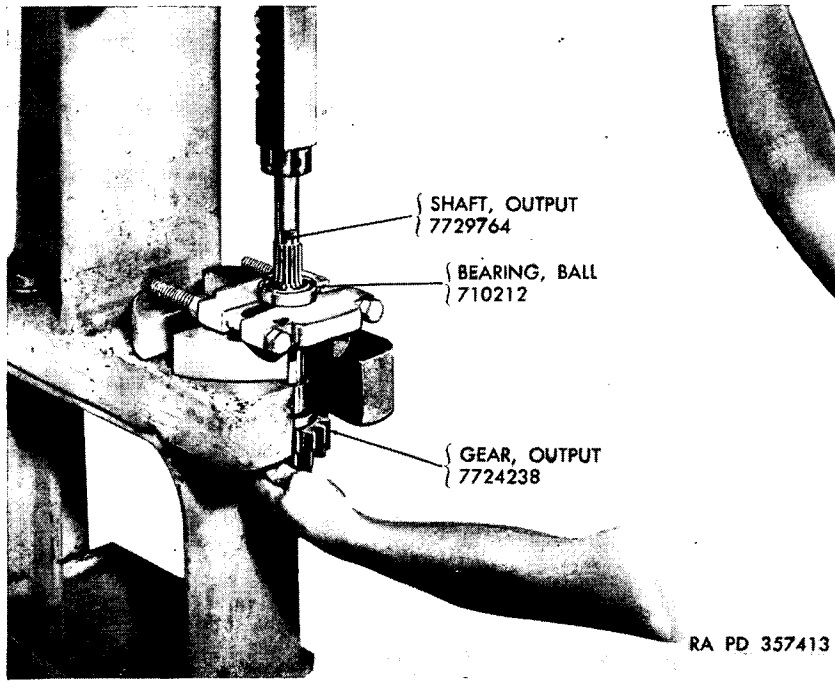


Figure 88. Pressing output shaft out of output shaft gear bearing.

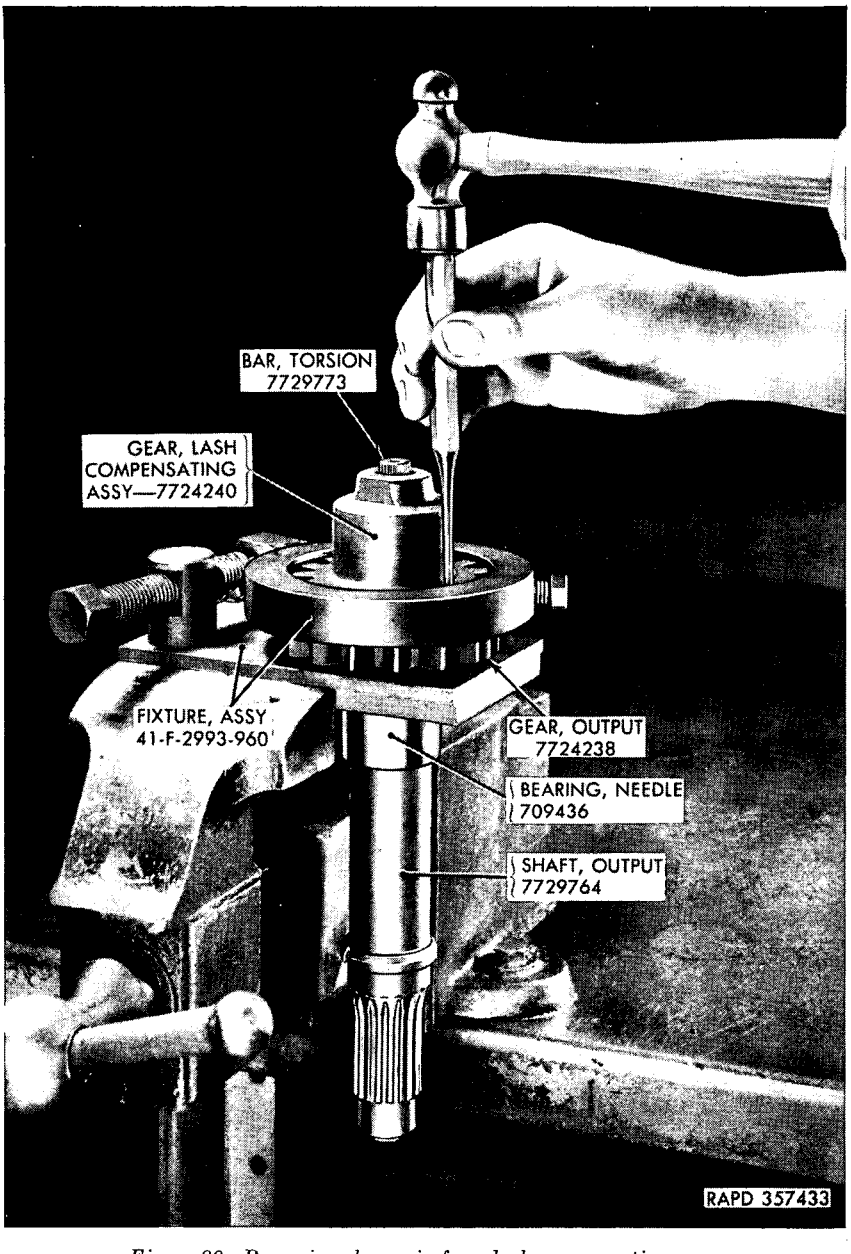


Figure 89. Removing shear pin from lash compensating gear.

(2) Place base of fixture assembly (41–F–2993–960) in a vise and slip shaft assembly through hole in fixture with three pins in base between output gear teeth. Loosen large screw in base post and bolt in fixture torsion ring. Set ring over output lash-compensating gear with lug at least 1¾ inches from base post. Tighten bolt in ring to engage lash compensating gear teeth and tighten screw to seat in socket in torsion ring. Turn screw about two turns after resistance is felt to free shear pin. Drive pin out of lash compensating gear with drift pin (fig. 89). If pin in lash compensating gear is not in line with hole in output gear, turn screw in or out to turn lash compensating gear. Release torsion ring and remove output shaft assembly from fixture. Remove retaining ring from output shaft gear end of torsion bar with snap ring pliers (41–P–1992–27), and pull out torsion bar and lash compensating gear assembly. Remove other retaining ring from torsion bar with snap ring pliers (41–P–1992–27), and pull lash compensating gear assembly off bar. Pull output gear off shaft and remove oil seal from output gear. Slide needle bearing off output shaft.

(3) Press shaft out of needle bearing race using arbor press and remover (41–R–2369–225) (fig. 90). Press needle bearings out of lash compensating gear assembly using arbor press and remover (41–R–2370–825) (fig. 91).

k. Disassemble Drive Gear Assembly (figs. 92 and 93). If the bearing lock nut has not been previously removed, as recommended in paragraph 37*d*, place motor mounting bracket in a vise, insert a pin or bar between drive gear teeth and housing counterbore, and remove nut with spanner wrench (41–W–3735–800) (fig. 57). Push drive gear assembly out of motor mounting bracket. Press bearing off drive gear using two ⅛-inch diameter pins and arbor press (fig. 93). Press bearing out of motor mounting bracket using remover and replacer (41–R–2373–860) and handle (7082196).

l. Disassemble Hand Crank and No-Back Assemblies (figs. 24, 94, and 95).

(1) Loosen nut on clamping bolt in crank and pull out handle assembly. Remove cotter pin, pull out lever pin, and remove lever. Grip end of spindle in vise and remove nut, washer, collar, sleeve, handle, and spring.

(2) Remove nut from crank locking bolt and pull crank out of housing. Remove spring damper and washer. Remove retaining rings with snap ring pliers (7081644). Tap no-back lock assembly out of either end of housing. Push locking bolt out of no-back driving member. Remove retaining ring from inside of no-back driving member with snap ring pliers.

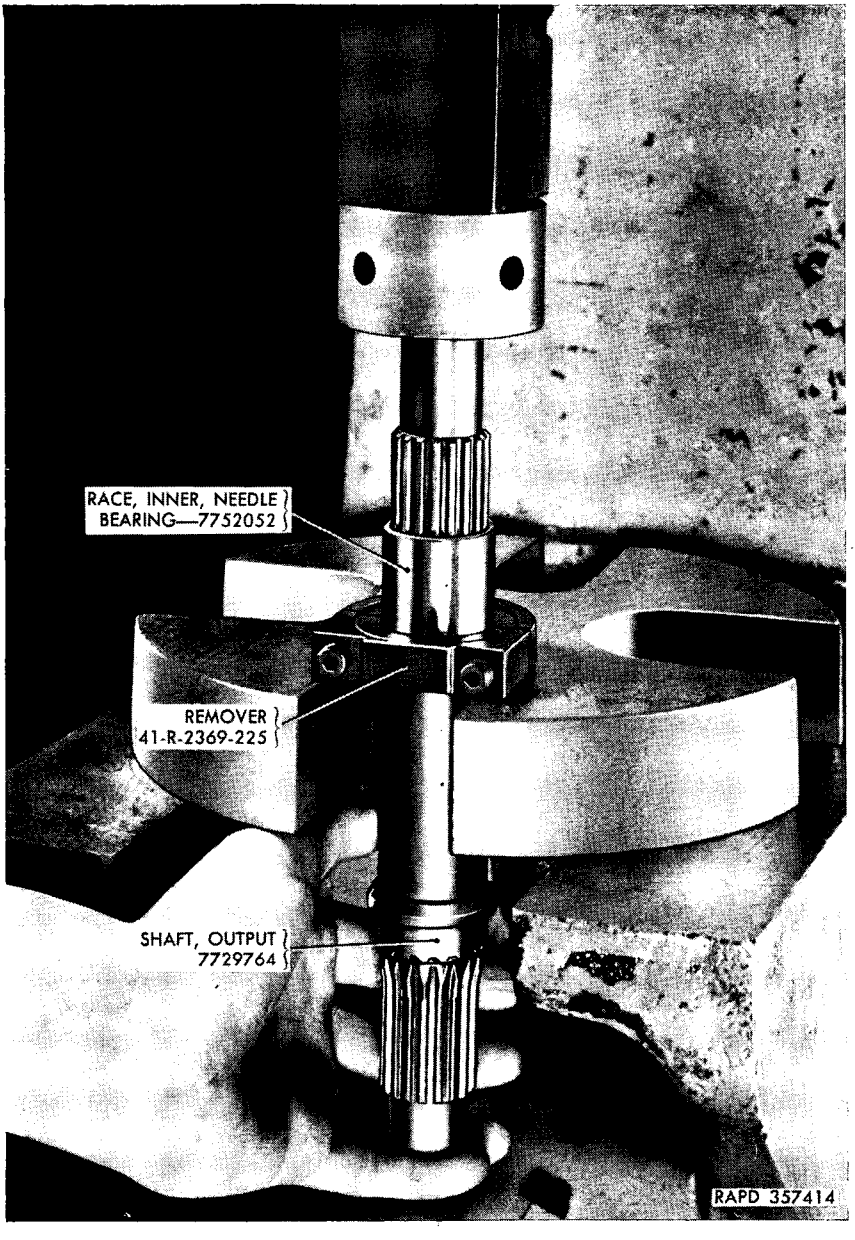


Figure 90. Removing bearing race from output shaft.

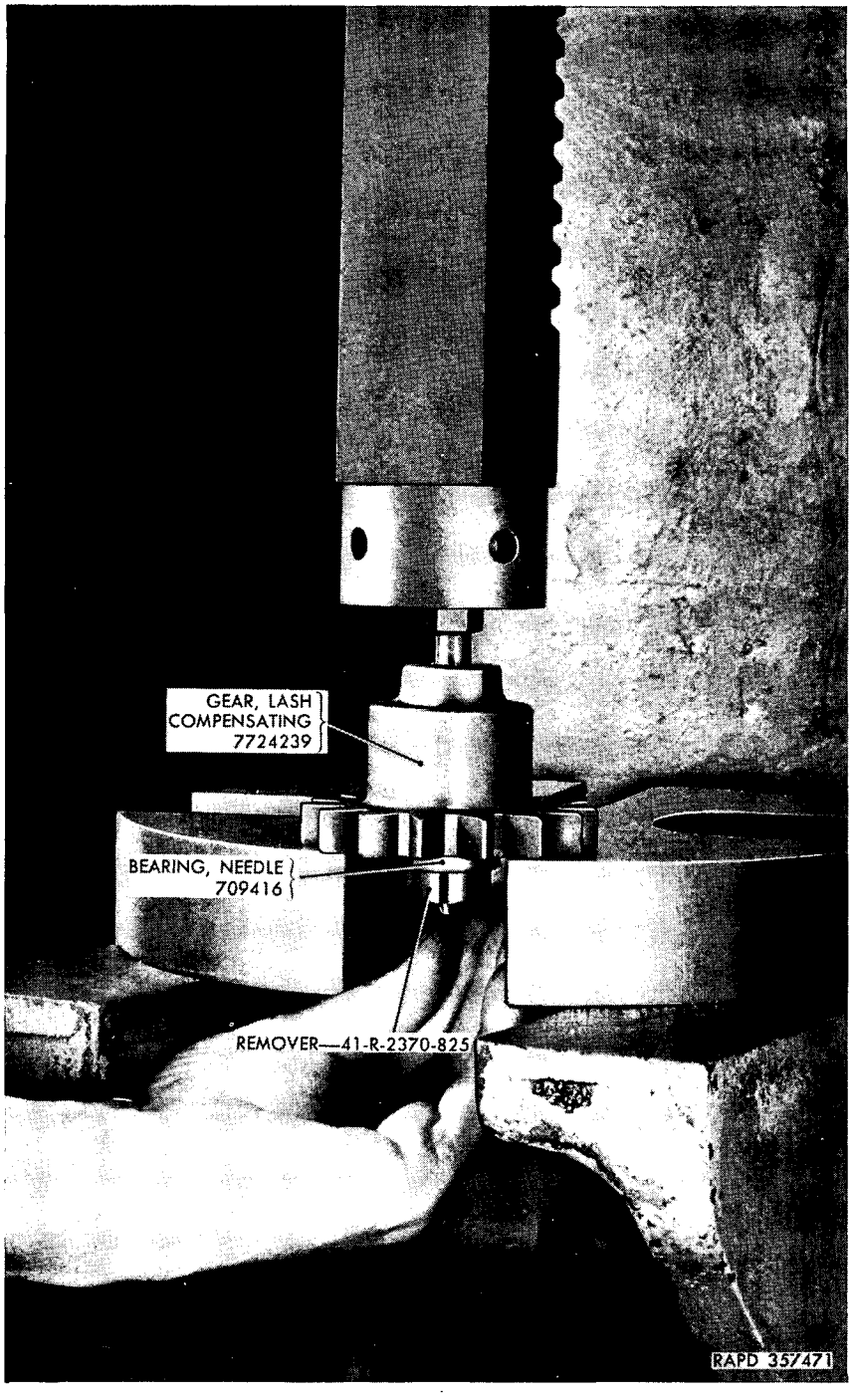


Figure 91. Pressing bearings out of lash compensating gear.

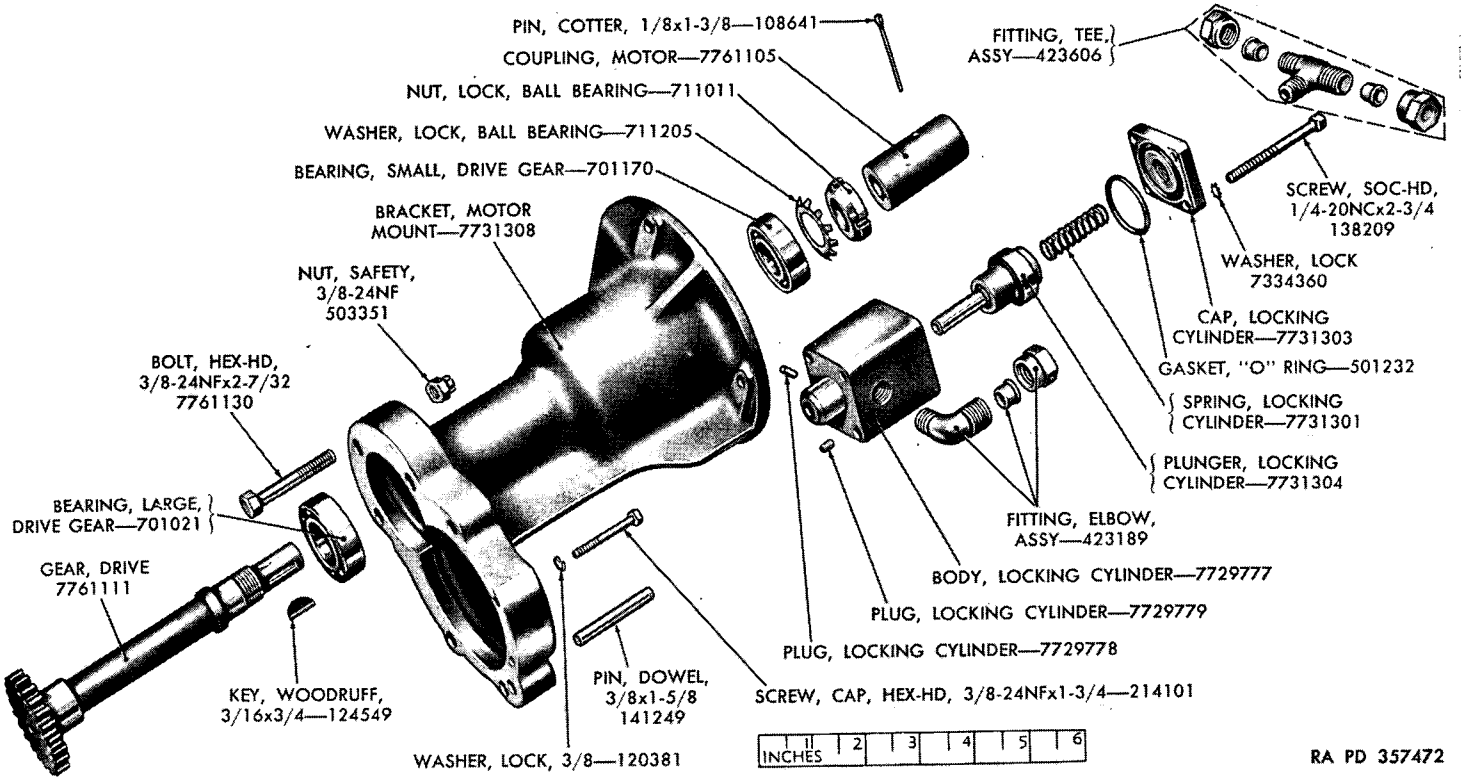


Figure 92. Motor mounting bracket, drive gear and hydraulic locking cylinder, exploded view.

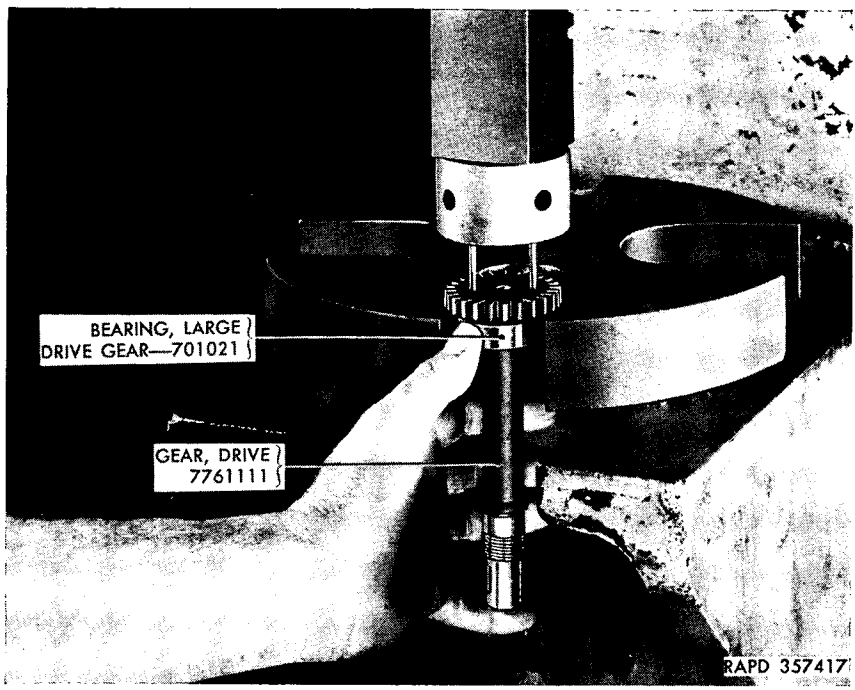


Figure 93. Pressing bearing off drive gear shaft.

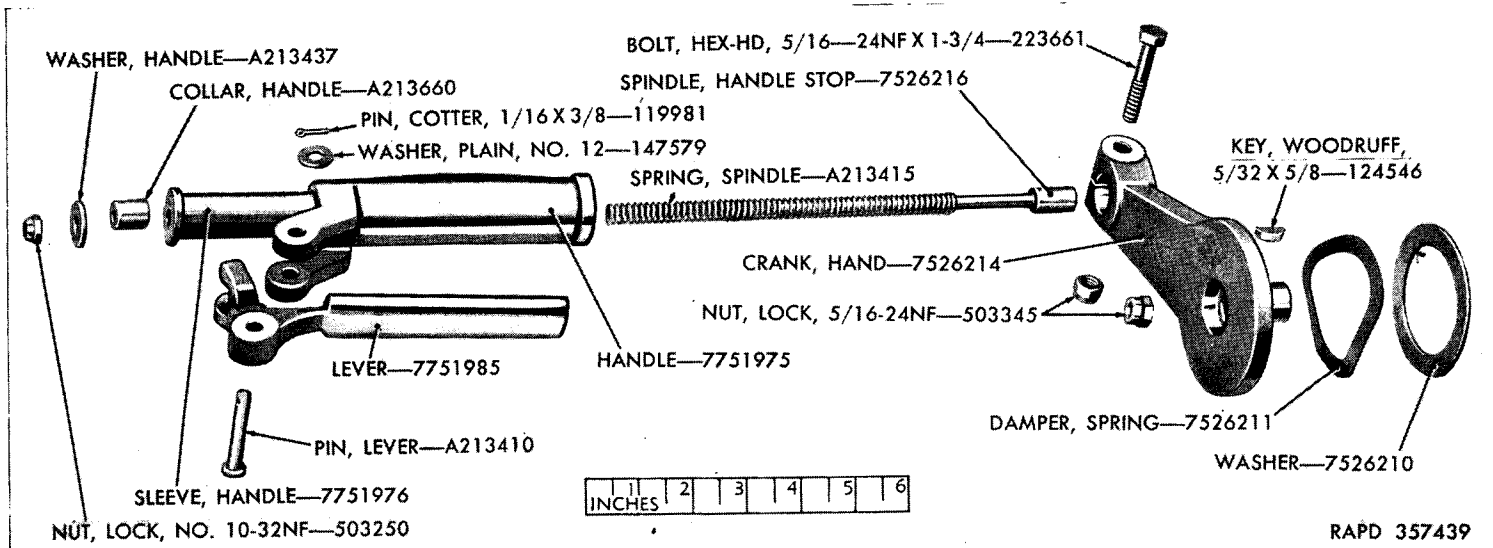


Figure 94. Hand crank assembly, exploded view.

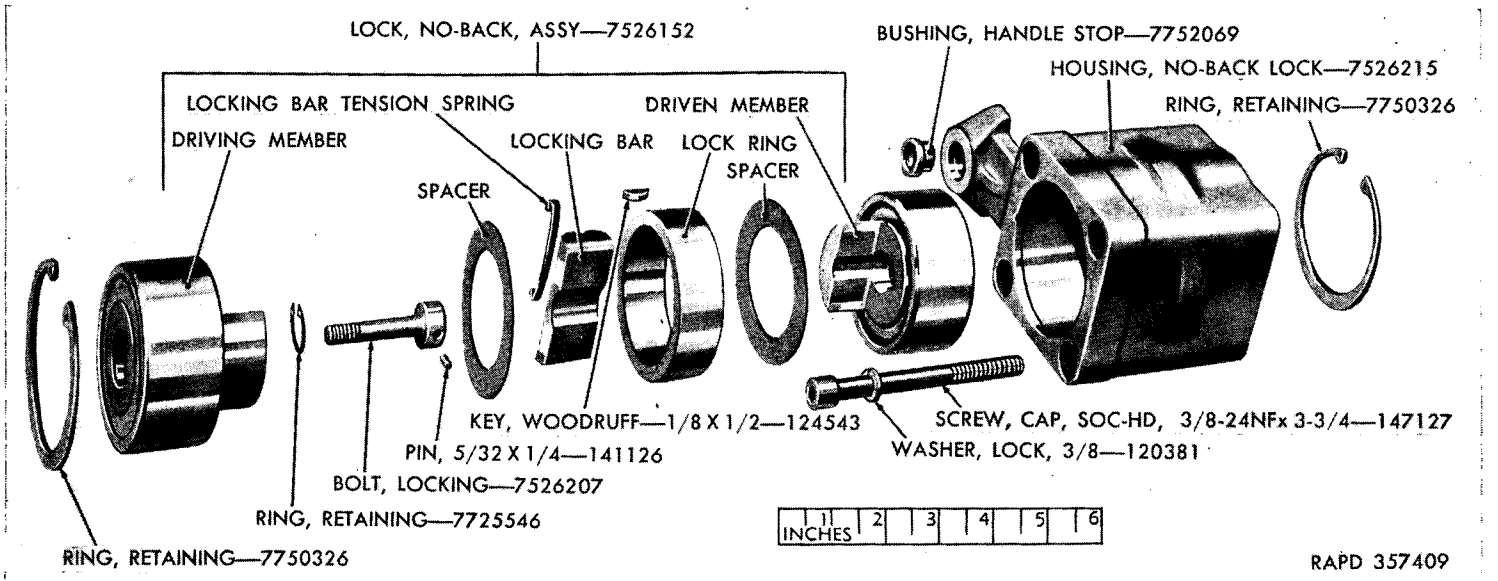


Figure 95. No-back assembly, exploded view.

m. REMOVE OIL BREATHER. If damaged, remove oil breather from housing.

38. Cleaning

All bearings must be very scrupulously cleaned of all grease, oil, chips, and grit before inspection. Also, grit, chips, and excess grease should be removed from gears. Flush with dry-cleaning solvent or volatile mineral spirits paint thinner, scrub with bristle brush, and dry out excess solvent or paint thinner with compressed air. Wipe or flush grease and dirt out of housing.

39. Inspection and Repair

a. INSPECTION.

(1) *Inspect bearings.*

Note. Refer to paragraph 70 for tolerances and wear limits.

To test for galling, pitting, and flat spots on balls and races, hold inner race stationary with axis horizontal, press down firmly, and partially rotate outer race in both directions. Try at different areas around bearing. Any bad spots will give the impression of grit in the bearing.

Note. Do not apply any end thrust or an erroneous test will result. Any grease or oil in bearing will mask bad spots.

(2) *Inspect gears.*

Note. Refer to paragraph 70 for tolerances and wear limits.

Check all teeth for pitting and spalling.

(3) *Inspect oil seal and gaskets.* Inspect wiping edge of shaft oil seal. It must be sharp and free from cracks or cuts. "O" ring gaskets must be firm and free from cracks and abrasions.

(4) *Inspect hydraulic locking cylinder and plunger.*

Note. Refer to paragraph 70 for tolerances and wear limits.

Pilot end of plunger must be straight and concentric with large diameter and free of score marks or burs.

(5) *Inspect springs.* Test all springs for proper length and force (par. 70).

b. REPAIR. Replace all worn gears and damaged or worn bearings with new parts. Replace defective shaft oil seal, gaskets, and springs with new parts.

40. Assembly

a. ASSEMBLE DRIVE GEAR ASSEMBLY (figs. 23, 57, 92, 129, and 130).

(1) Pack bearings with lubricant prescribed on lubrication order (TM 9–718).

(2) Press larger bearing onto drive gear. Press smaller bearing into bracket with remover and replacer (41–R–2373–860). Push gear assembly into bracket, thread bearing lock washer over shaft, and screw lock nut loosely onto shaft. Lock nut can be tightened later when motor mounting bracket and retainer are assembled to housing and cover. To tighten lock nut before assembly to housing and cover, place motor mounting bracket in a vise, insert a pin or bar between drive gear teeth and housing, and tighten nut with spanner wrench (41–W–3735–800) (fig. 57).

b. Assemble Output Shaft Assembly (figs. 23, 84, 85, 96, 129, and 130).

(1) Pack bearings with lubricant prescribed on lubrication order (TM 9–718).

(2) Coat seal and gaskets with lubricant prescribed on lubrication order.

(3) Press inner race of needle bearing on output shaft. Slip oil seal on output gear with wiping lip pointing away from gear or toward inside of traversing mechanism housing when assembled therein. Thread needle bearing and output gear on shaft.

(4) Press one needle bearing to bottom of counterbore in lash compensating gear and other needle bearing flush with gasket surface using replacer (41–R–2390–175) (fig. 96). Place "O" ring gaskets in grooves in lash compensating gear.

(5) Thread torsion bar into output shaft and slip lash compensating gear assembly on shaft and torsion bar.

Note. One tooth on each end of bar and one groove in gear and shaft are omitted for proper angular location.

Compress "O" rings and install retaining rings on both ends of bar with snap ring pliers (7081640).

Note. A sharp edge is formed in hole on one side of retaining ring in stamping it. Assemble with this side of retaining ring facing out.

(6) Install output shaft assembly in fixture assembly (41–F–2993–960) and rotate lash compensating gear with fixture torsion ring the distance between two teeth on output gear. The slot in output gear should then be visible in shear pin hole in lash compensating gear. Drive pin into lash compensating gear until it is one-sixteenth inch below surface of lash compensating gear. Release fixture torsion ring and remove output shaft assembly from fixture.

(7) Press large ball bearing, output shaft gear, and small bearing onto output shaft.

Note. Do not press on either end of torsion bar in shaft or retaining rings will snap off.

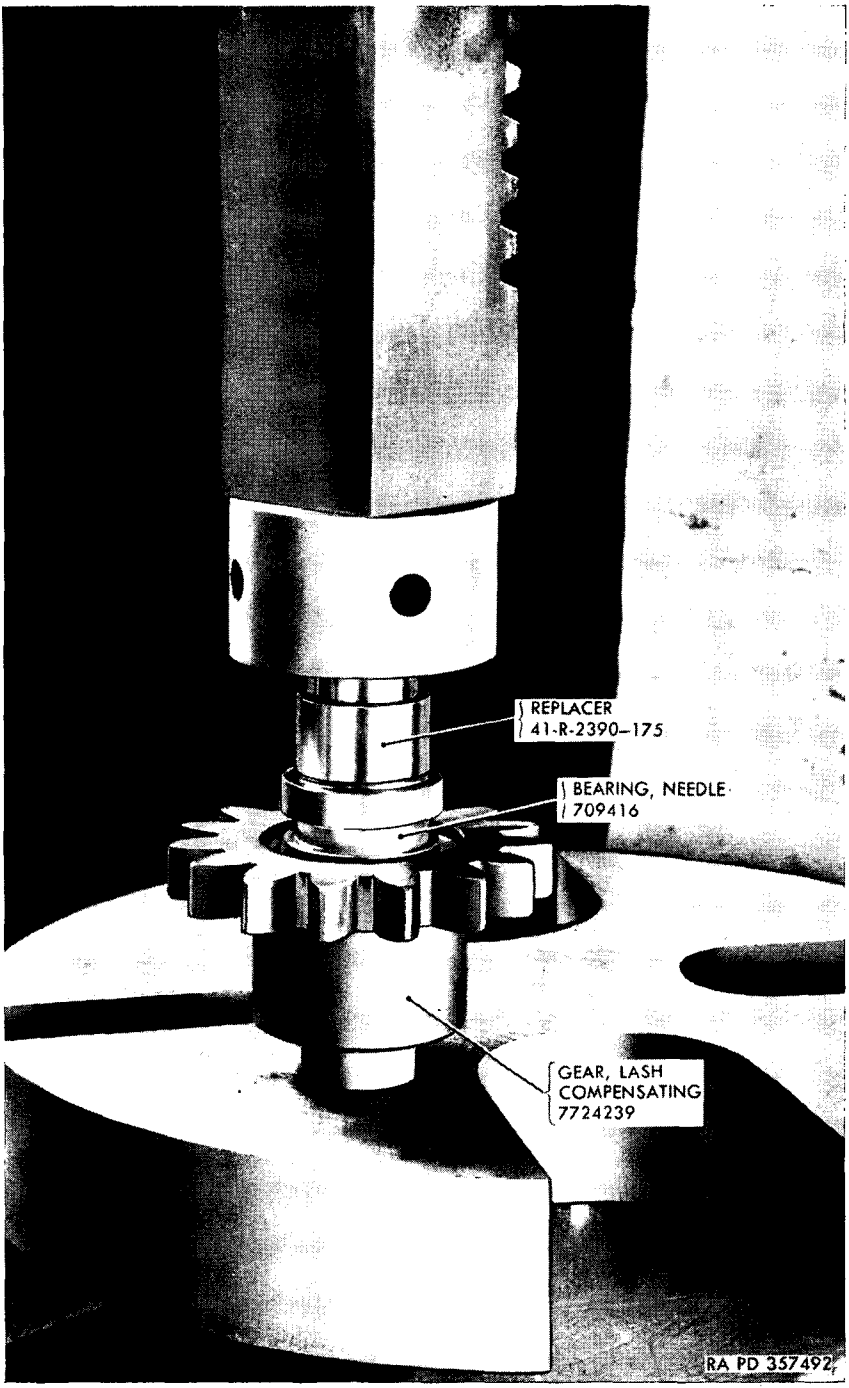


Figure 96. Pressing bearings into lash compensating gear.

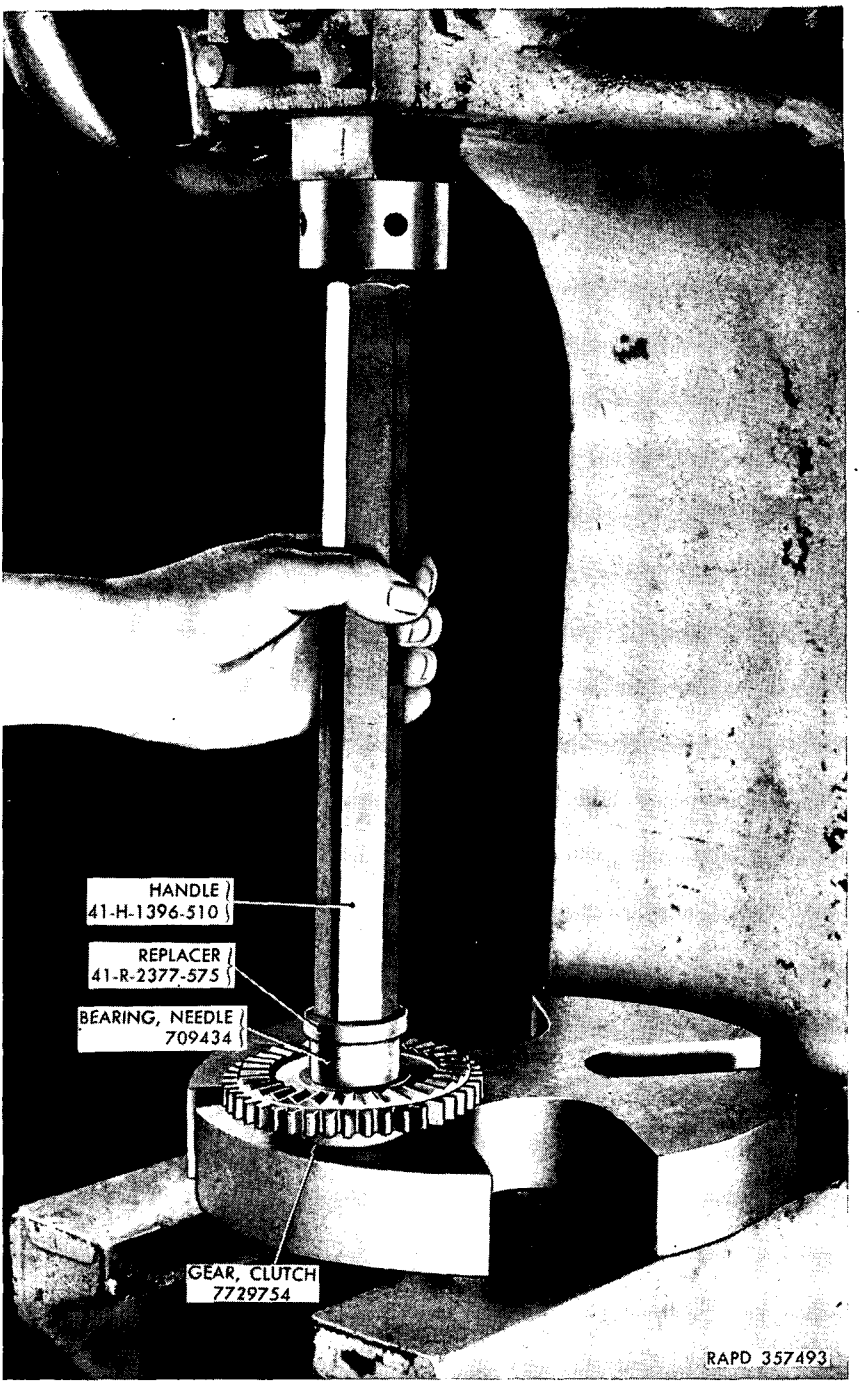


Figure 97. Installing bearing into clutch gear.

c. Assemble Idler Assembly (figs. 23, 80, 81 and 129).

(1) Pack bearings with lubricant prescribed on lubrication order (TM9–718).

(2) Press idler gear onto shaft until shaft protrudes one-half inch. Press bearing onto shaft to within one-sixteenth inch of gear, blow out any chips or dust, and press both home.

(3) Press idler pinion onto shaft until shaft protrudes one-half inch. Press bearing onto shaft to within one-sixteenth inch of pinion, blow out any chips or dust between pinion and gear and between bearing and pinion, and press both home.

d. Assemble Clutch Assembly (figs. 23, 74, 75, 77, 97, and 129).

(1) Pack bearings with lubricant prescribed on lubrication order (TM 9–718).

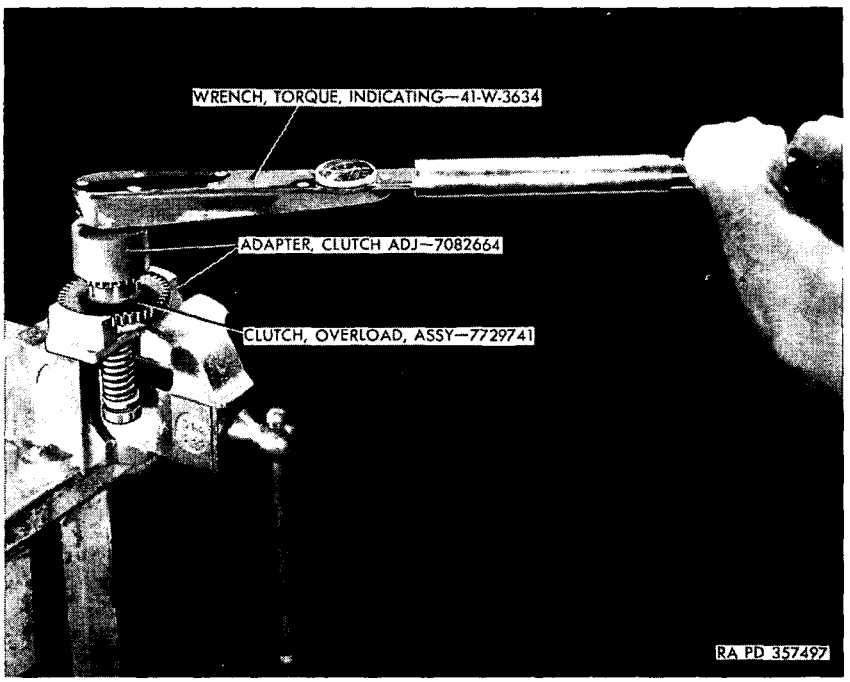


Figure 98. Adjusting overload clutch.

(2) Thread thrust washer over shaft and press inner race of needle bearing onto shaft. Press needle bearing into clutch gear using replacer (41–R–2377–575) with handle (41–H–1396–510) (fig. 97), and slip assembly onto shaft. Install washer and retaining ring with snap ring pliers (7081641).

(3) Coat clutch gear teeth and serrations on gear and clutch with lubricant prescribed on lubrication order. Slip clutch over

splines on shaft and thread shim washers, spring, and retaining washer over shaft.

(4) Set assembly in arbor press and compress spring far enough with adapter (7082911) (fig. 77) to allow spring retainer to be installed. Release spring slowly while observing if retainer is seating properly. ***Warning:*** *Refer to warning in paragraph 37h (2).*

(5) Press bearing onto retainer end of clutch shaft. Press bearing onto gear end of clutch shaft.

(6) Place adapter (7082664) into a vise. Install clutch assembly into adapter and test clutch with torque wrench (41–W–

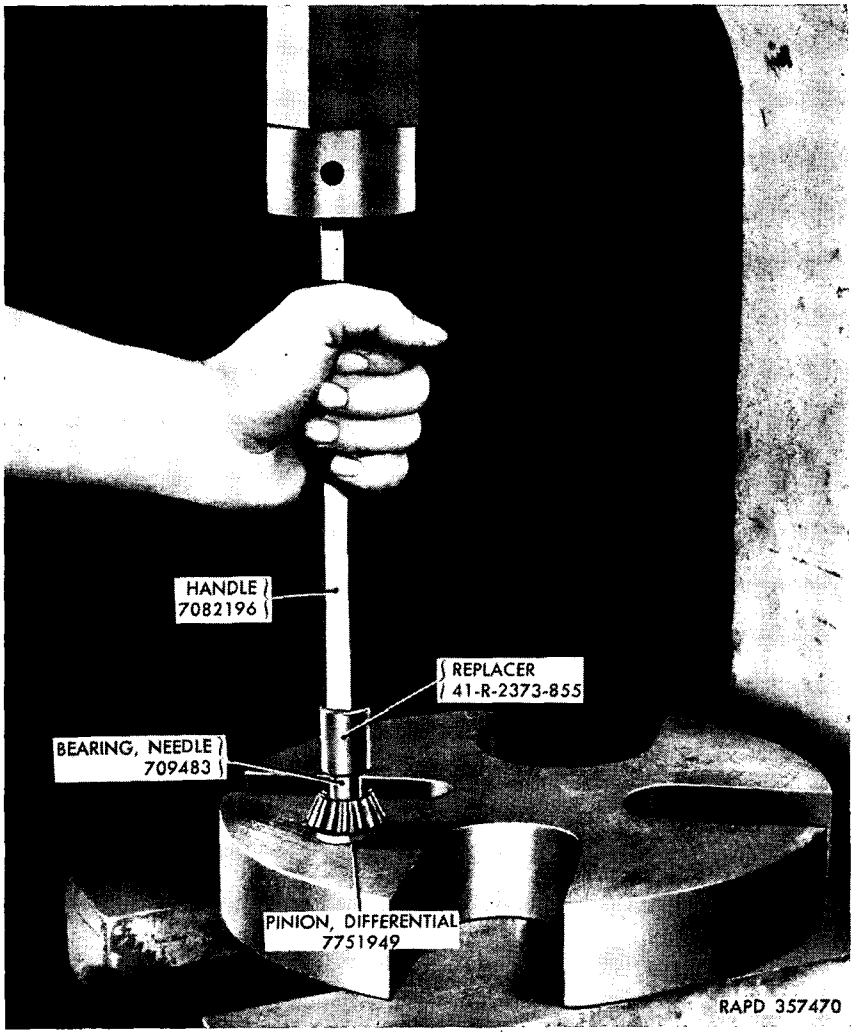


Figure 99. Installing needle bearing in differential pinion.

3634). If torque is not 144 lb-ft, disassemble as outlined in paragraph 37*h* and change number of washers between spring and clutch.

e. Assemble Differential Assembly (figs. 23, 24, 64, 65, 66, 69, 129, and 130.

(1) Pack all bearings with lubricant prescribed on lubrication order (TM 9–718).

(2) Tap two keys into keyways in carrier and press on differential carrier gear and bearing.

(3) Press bearing on differential motor shaft. Tap small key into carrier end of shaft and press gear on shaft. Install retaining ring with snap ring pliers (41–P–1992–27). Thread shaft assembly into carrier. Press needle bearings into pinions flush with thrust surface of pinions, using replacer (41–R–2373–855) and handle (7082196) (fig. 99).

(4) Set pinions on gear in carrier. Pack thrust bearings with lubricant prescribed on lubrication order and install in carrier. If all original parts within carrier are used, assemble shims, caps, and shaft in same side of carrier from which they were removed (par. 37*g* (3)). Screw nut on pinion shaft and tighten to 75–80 lb-in torque (fig. 69).

(5) If any new parts are used in carrier, assemble caps and pinion shaft with about 0.025-inch shims under each cap. Tighten nuts on shaft to 75–80 lb-in torque (fig. 69). Rotate carrier slowly while testing one pinion for lash at same point on gear. Remove nut, pull out shaft, remove caps, and shim to reduce lash to correct value (par. 70). Coat gears with lubricant prescribed on lubrication order.

(6) Press bearing onto differential hand crank shaft against shoulder. Tap key into shaft and press gear in place. Install retaining ring with snap ring pliers (41–P–1992–27). Press bearing onto differential cover and push shaft assembly into cover.

(7) If all original parts are used in carrier, place shims on carrier, set cover in place, replace six screws, and stake screws into cover.

(8) If any new parts are used in carrier, place about 0.010-inch shims on carrier and tighten cover with three screws. Twist on shaft while holding carrier to test for lash. Try at various positions to be sure there is no binding at any point. Remove shims to adjust lash to correct value (par. 70). Replace six screws, draw up tightly, and stake screws into cover.

(9) Press bearing onto motor driven gear. Tap key into keyway in differential motor shaft, slip retainer over shaft and carrier bearing, and tap motor driven gear assembly into retainer.

Install retaining ring on shaft with snap ring pliers (41–P–1992–27).

f. Assemble Hand Crank and No-Back Assemblies (fig. 23, 24, 94, 95, 129, and 130).

(1) Grip spherical end of spindle in vise and slip spring handle, sleeve, collar, and washer in place. Press down on washer and screw on nut. Remove assembly from vise, assemble lever to handle with pin, and install washer and cotter pin.

(2) Install retaining ring in bottom groove in no-back lock assembly housing with snap ring pliers (7081644). Tap driven member into housing until lug protrudes one-half inch. Tap key into keyway in lock ring and slip one spacer over the driven member lug into housing. Place locking bar tension spring into groove in locking bar, slip spring over lug on driven member, and set lock ring into housing over locking bar. Line up key with keyway, turn lug on driven member on same side of center as key, and pry ring over with screwdriver. Tap ring one-quarter inch below surface of housing and slip spacer on ring. Install retaining ring in groove in driving member with snap ring pliers, thread locking bolt into bore, and assemble driving member into housing. Install retaining ring in upper groove in housing, above driving member, with snap ring pliers (7081644). Tap key into keyway in crank. Install washer and damper spring, push crank into driving member, and fasten with lock nut.

g. Assemble Traversing Gear Mechanism From Subassemblies (figs. 23, 63, 129, and 130).

(1) Set output shaft assembly into housing. Push needle bearing and oil seal into their respective counterbores in housing.

Note. Be sure oil seal is not cocked against gear on under side

Push retainer into housing and over bearing and hold in place loosely with two screws and lock washers. Spin shaft to check running clearance.

(2) Set differential assembly in housing and spin to check for clearance. Remove assembly from housing.

(3) Set clutch assembly in housing and hold caps loosely with two screws and lock washers in each. Check for clearance in housing by spinning clutch.

(4) Set idler shaft assembly in housing and hold retainer and cap loosely with two screws and lock washers each. Turn gear train to check for any binding.

(5) Set differential assembly in housing. Spin entire gear train to check for binding. Set spacer in place over differential hand crank shaft.

(6) Coat all gears with lubricant prescribed on lubrication order (TM 9–718).

(7) Lay cover down on housing and drive two dowel pins into cover and housing one-sixteenth inch below surface of cover. Install 10 screws and lock washers in upper holes in retainers and caps. Install hand crank and no-back assemblies with four screws and lock washers. Tighten all 24 screws to 180–200 lb-in torque. Install 15 screws and lock washers in cover and tighten to 375–400 lb-in torque with exception of one screw opposite output gear (farthest away from motor mounting bracket). Tighten this screw to 225–250 lb-in torque only.

Note. If excessively tightened, this screw may strip out of housing.

(8) Bolt motor mounting bracket to housing with dowel bolt and drive in dowel pin one-sixteenth inch below surface of bracket. Install two bolts, three screws, and lock washers and tighten to 200–225 lb-in torque.

(9) Install hydraulic locking cylinder assembly on bracket with port 16 facing toward output shaft. Place spring in plunger, and fasten cap and packing to cylinder with four screws and lock washers (fig. 56). Rotate tee in cap one-eighth turn clockwise. If removed (par. 37*m*), install oil breather.

(10) Tighten bearing lock nut on drive gear with spanner wrench (41–W–3735–800) and lock in place by bending up one ear on lock washer. Install key in shaft.

Note. Key must fit tightly in shaft or it will fall out when assembling motor to bracket. Tap on convex edge with centerpunch to swell key and tap into keyway.

(11) Slip handle assembly into crank with $\frac{1}{64}$-inch clearance between crank and handle, and fasten with bolt and nut. Check clearance between spindle spacer and upper end of sleeve, with spindle seated in stop bushing. If it is less than one-sixty-fourth inch, disassemble and face difference off crank end of both handle and sleeve and reassemble. When properly adjusted, spindle seats firmly in bushing with no play.

(12) After making tests recommended in paragraph 41 and before installing traversing gear mechanism in tank, assemble hydraulic motor to bracket (par. 58).

41. Test Before Installation

a. Test for Binding in Gear Mechanism. Rotate hand crank to check for any binding in gear mechanism.

b. Test Operation of Hydraulic Locking Cylinder. To check if hydraulic locking cylinder is in proper operating condition, blow dry

compressed air into fitting in port 16 of cylinder and rotate motor drive shaft ⅛ turn. Release air and turn shaft slightly in both directions while listening to hear plunger snap into hole in motor driven gear. Repeat for all six holes in motor driven gear.

Section VI. REBUILD OF GUNNER'S AND COMMANDER'S TRAVERSE CONTROLS

42. Disassembly

a. Remove Controls. Refer to paragraph 24.

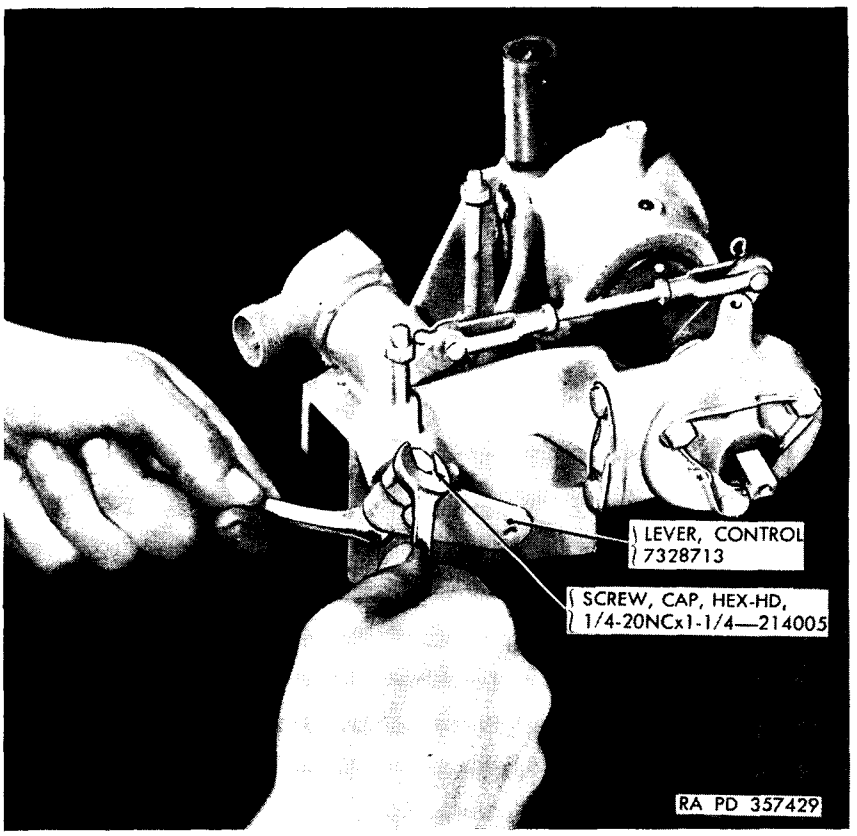


Figure 100. Removing or installing of lever on gunner's shifter control assembly.

b. Disassemble Gunner's Shifter Control (figs. 6, 25, 100, 101, 102, 103, 104, and 105).

(1) Remove two nuts and screws and pull off two control levers (fig. 100). Pull clips off pins in yokes and clutch lever (fig.

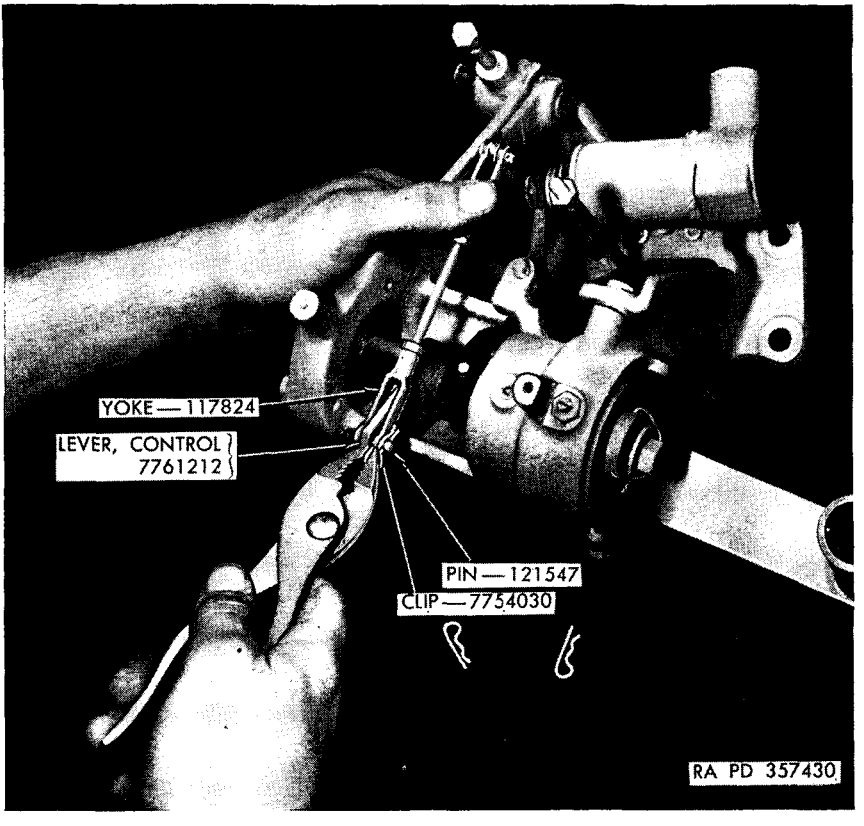


Figure 101. Removing clips from yokes and clutch lever.

101). Remove two pins and control rod assembly. Remove four screws and washers and lift off solenoid.

Note. Armature assembly, spring, and cup washer are loose and will drop off. Avoid damage to soft iron armature.

Pull out clutch lever pin, and remove clutch lever.

(2) Remove lock wire and three screws (fig. 102) and pull out cap, spacer, washer, control lever, clutch, and shaft. If worn (par. 71), remove bearing from cap using drift pin through shaft hole in cap. If "O" ring gasket in cap is defective, pull out with scriber or other pointed instrument.

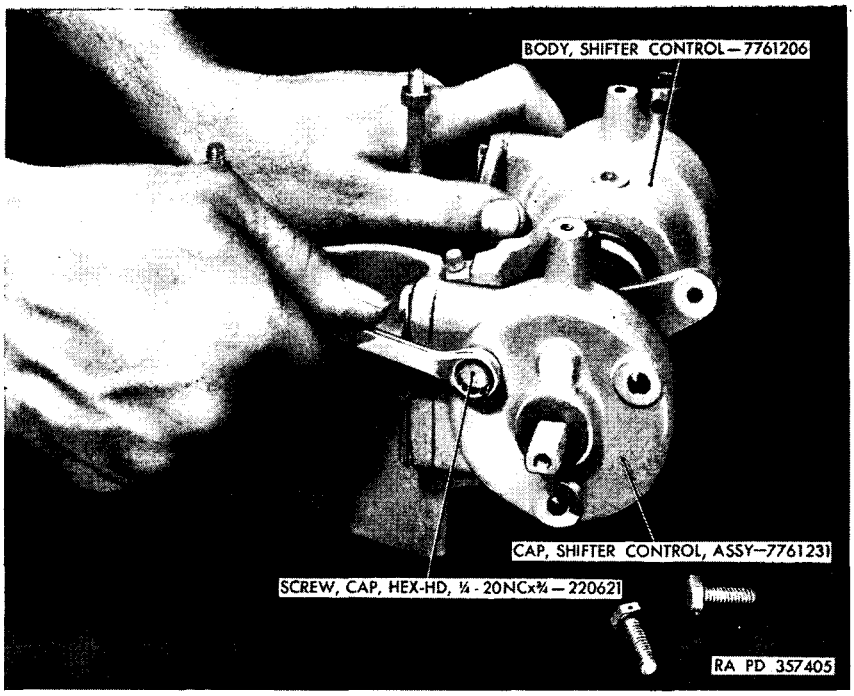


Figure 102. Removing or installing of cap on gunner's shifter control.

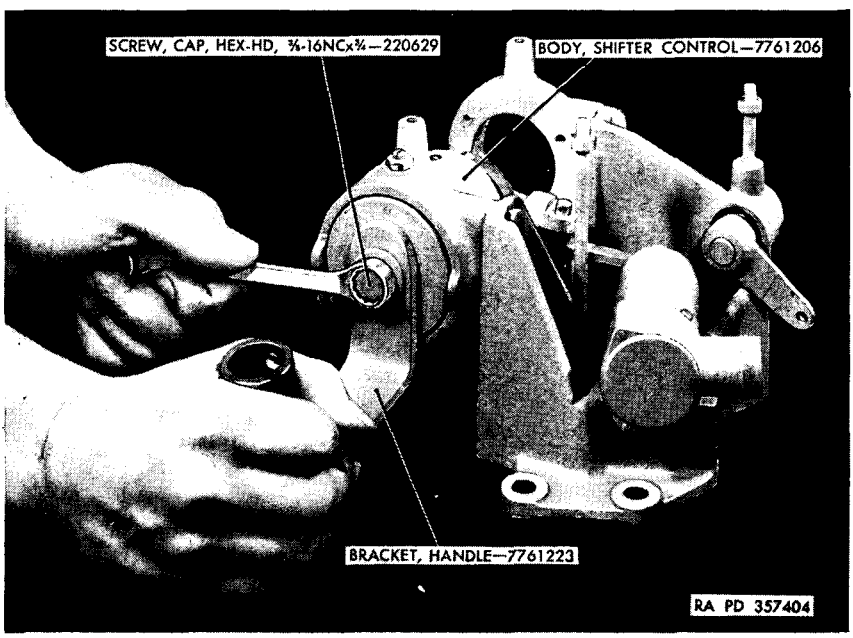


Figure 103. Removing or installing of bolt on gunner's shifter control shaft.

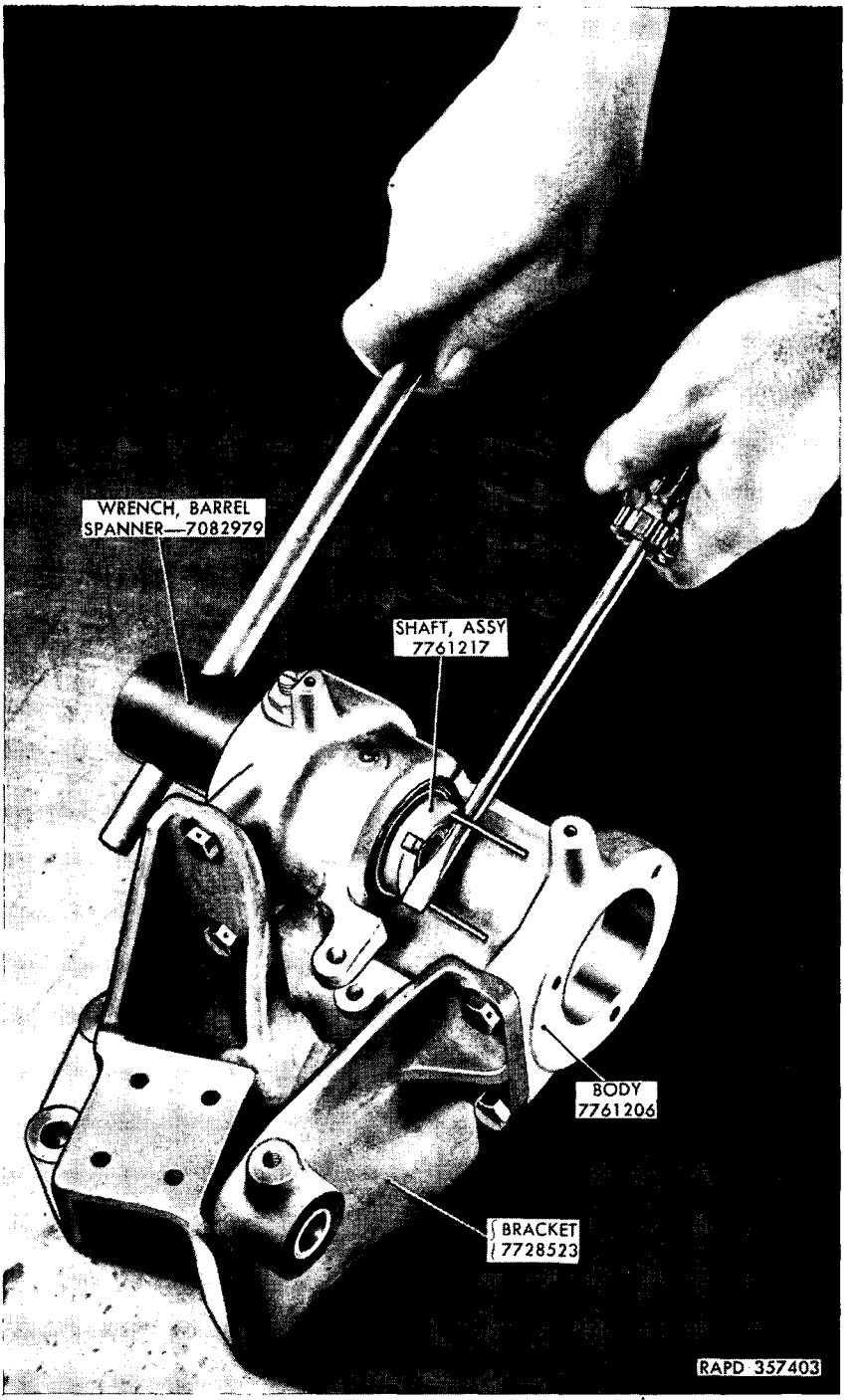


Figure 104. Removing bearing lock nut from gunner's shifter control shaft.

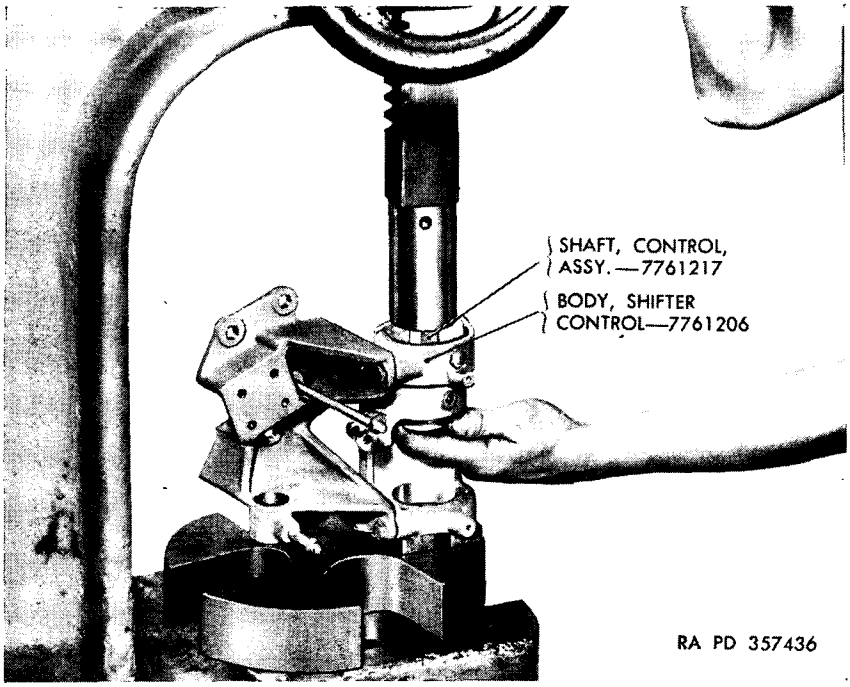


Figure 105. Pressing shaft out of bearing in gunner's shifter control housing.

(3) Remove lock wire and screw (fig. 103), and pull off handle bracket, disk, spring, and washer. Disengage ear on bearing lock washer and remove lock nut with barrel spanner wrench (7082979), screwdriver, and two ⅛-inch pins (fig. 104).

(4) Press shifter control shaft assembly out of body (fig. 105), and remove two bearings and spacer.

(5) Remove lock wire and four screws from bracket assembly and body. If worn (par. 71), press bushings out of traverse shifter mounting bracket and commander's traverse lever (fig. 25).

(6) Remove four screws from end bell and pull end bell off solenoid assembly. Remove two nuts, two lock washers, one flat washer, and two cable terminals. Remove two nuts, a lock washer, three flat washers, silver contact screw, and insulator. Remove two nuts, two lock washers, two flat washers, insulator with spring assembly, flat insulator and two cylinder insulators from solenoid assembly.

c. Disassemble Gunner's Control Link Assembly and Bracket (figs. 30 and 106). Loosen lock nuts on links and remove ball joint assemblies and lock nuts. Remove cotter pin and adjustable screw. Lift out ball screw, ball

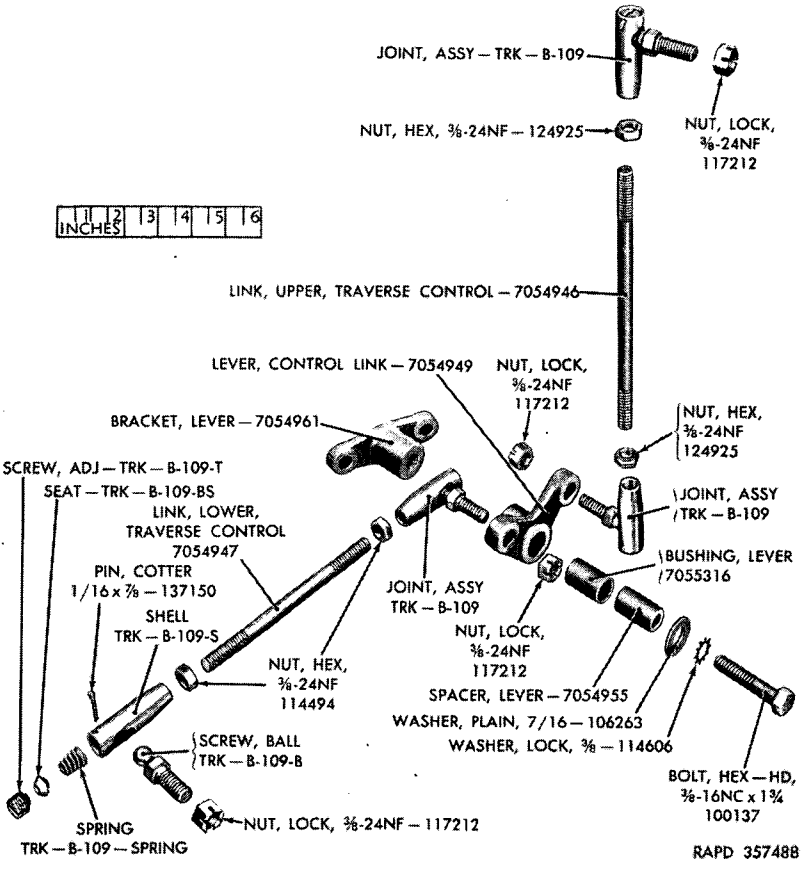


Figure 106. Gunner's control link assembly and bracket, exploded view.

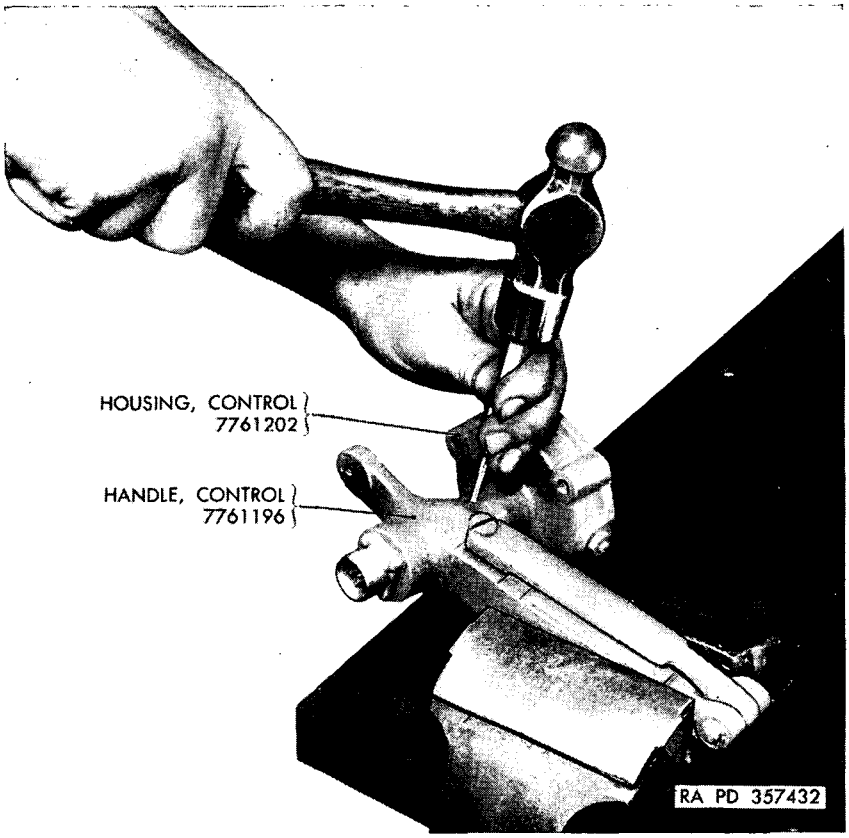


Figure 107. Removing taper pin from commander's control housing.

seat, and spring. Remove bolt, washers, spacer, and lever assembly from bracket. If bushing is worn (par. 71), press out of lever.

d. Disassemble Commander's Control (figs. 7, 27 and 107–110).

(1) Drive out pin in handle with drift pin (fig. 107), remove handle from pivot assembly, and pull shaft, spring, and thrust washer from pivot housing.

(2) If needle bearings are defective (par. 71), drive out of pivot housing using drift pin through hole from side opposite each bearing.

Note. These bearings are damaged on removal and should not be removed unless defective.

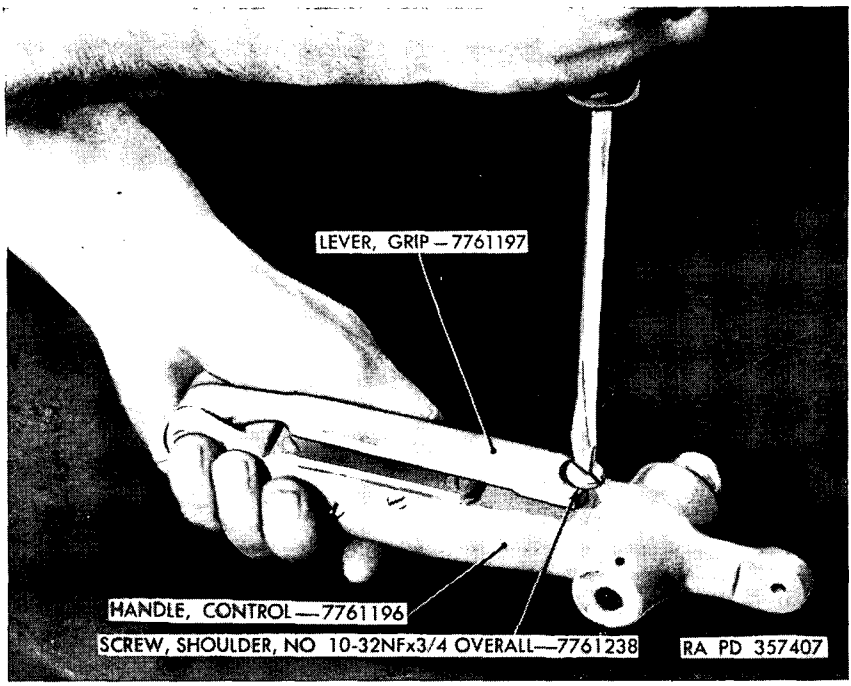


Figure 108. Removing grip-lever limit screw from commander's control handle.

(3) Remove screw and spring from free end of commander's control lever (fig. 108). Remove retaining ring with snap ring pliers (41–P–1992–27) (fig. 109). Remove pin and lever from handle.

(4) Remove four screws and remove diaphragm plate and diaphragm (fig. 110). Remove two screws and gaskets, and pull out switch. Disconnect cables, remove four screws and washers, and pull out receptacle assembly.

e. Disassemble Commander's Flexible Control (figs. 30 and 111). Loosen lock nuts on control and unscrew rod ends and lock nuts. Unscrew lubricating fittings. Cable assembly will not be disassembled further.

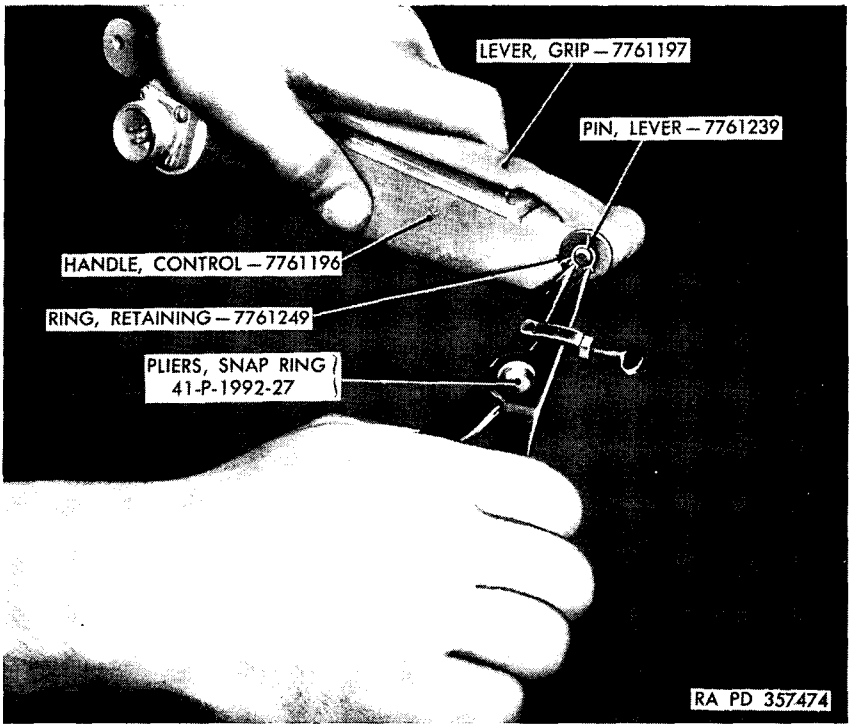


Figure 109. Removing retaining ring from commander's grip lever pin.

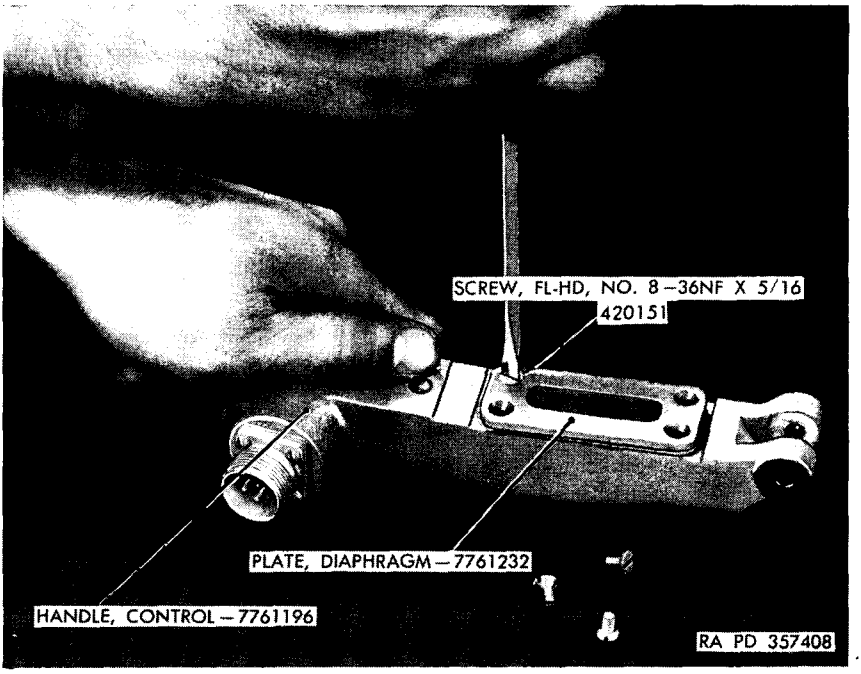


Figure 110. Removing screws from diaphragm plate

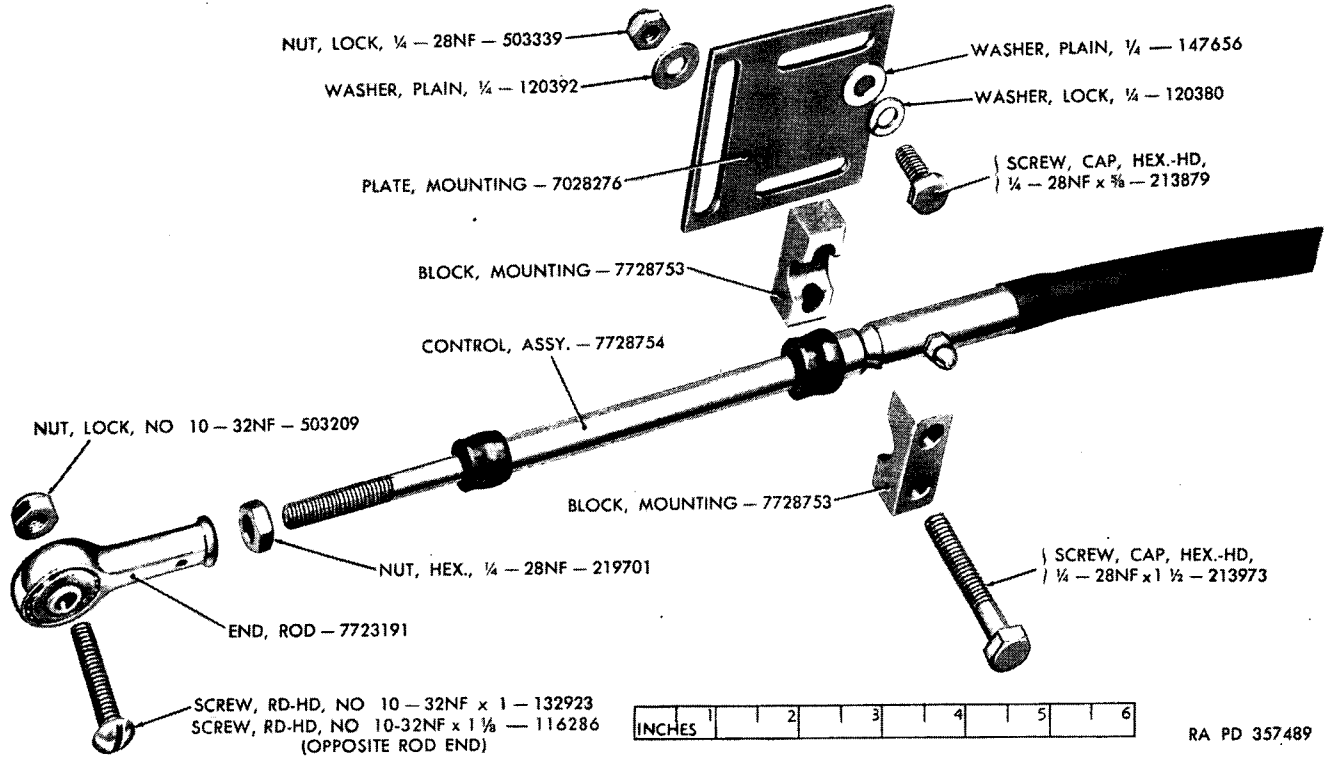


Figure 111. Commander's flexible control, exploded view.

43. Cleaning

All bearings must be very scrupulously cleaned of all grease, oil, chips, and grit before inspection. Flush with dry-cleaning solvent or volatile mineral spirits paint thinner and scrub with bristle brush. Dry out excess solvent or paint thinner with dry compressed air.

44. Inspection and Repair

a. INSPECTION.

(1) *Inspect bearings.* Refer to paragraph 71 for tolerances and wear limits. To test for galling, pitting, and flat spots in bearings, hold inner race stationary with axis horizontal, press down firmly, and partially rotate outer race in both directions. Try at different areas around bearing. Any bad spots will give the impression of grit in the bearing.

Note. Do not apply any end thrust or an erroneous test will result. Any grease or oil in bearing will mask bad spots.

(2) *Inspect rings.* Inspect ears on handle centering springs to be sure they are not cracked or broken off. When spring is free, they should be 30° apart. Test other springs for proper lengths and forces (par. 71).

(3) *Test solenoid.* When in good condition, solenoid should draw 4.2 amps (momentary current) inrush, and 0.53 amps, closed (holding current), at 24 volts. Plunger should move freely and draw in rapidly when solenoid is energized. If plunger does not move and solenoid buzzes when energized, plunger is binding.

(4) *Test switch.* Switch should have $\frac{3}{64}$-inch pretravel before contacts close and $\frac{1}{32}$-inch overtravel after closing. If solenoid is good ((3) above) but does not operate when switch is depressed, switch should be replaced.

(5) *Inspect receptacle.* Inspect wiring for broken or worn insulation or bad connections. Check receptacle for corrosion on points, deteriorated insulation, or loose solder connections.

(6) *Inspect bushings.* Refer to paragraph 71 for tolerances and wear limits.

Note. Bushing in traverse control shaft cannot be removed, and shaft and bushing assembly must be replaced by new assembly if bushing is worn.

(7) *Inspect commander's flexible control cable.* Pull on control end to check if cable is broken. Rod end bushings must swivel freely in body.

b. REPAIR. Replace worn bearings and defective springs, switch, wiring, or receptacle. Replace solenoid assembly if it is burned out.

Remove burs or replace plunger if it is not free in solenoid. Replace flexible control if broken or inoperative.

45. Assembly

a. Assemble Gunner's Shifter Control (figs. 6, 25, 26, and 131).

(1) Pack bearings with lubricant prescribed on lubrication order (TM 9–718).

(2) Press bushings into gunner's traverse shifter, mounting bracket and control shaft, and into commander's traverse lever. Fasten bracket to body with four screws, and lock screws with wire.

(3) Press one bearing onto traverse control shaft. Slip shaft assembly into body and tap to bottom of counterbore. Slip spacer over shaft and tap second bearing over squared end of shaft and into counterbore.

Note. Seal side of each bearing must face outward.

Replace lock washer and lock nut using barrel spanner wrench (7082979), screwdriver, and two ⅛-inch diameter pins (fig. 104). Lock nut in place by engaging one ear of lock washer.

(4) To assemble handle centering spring to spring-centering disk, hold disk with axis horizontal and two pins above horizontal center line of disk. Place spring on disk with right-hand pin between two ears on spring. Twist ear on right side of this pin clockwise and hook on other pin.

(5) Turn traverse control shaft in body until clutch groove is horizontal and to the right when facing grooved end of shaft. Slip large washer and disk and spring assembly over squared end of shaft so spring stop screws are on same side of centering-spring ears as the pins in disk.

(6) Slip handle bracket assembly on shaft, install washer and screw, and lock screw with lock wire. Loosen lock nuts and adjust spring stop screws so shaft has no free radial movement. Tighten lock nuts. Install handle with screw and nut.

(7) Insert two cylinder insulators (fig. 26), one flat insulator, insulator with spring assembly, two flat washers, and two lock washers over holding coil and ground studs in solenoid assembly. Tighten in place with two nuts. Insert flat washer over holding coil stud. Insert silver contact screw in hole "A" of insulator, and slip insulator hole "B" over holding coil stud and hole "GRD" over ground stud. Insert two flat washers and lock washer over ground stud and fasten with nut. Insert a flat washer, terminal "B" and a lock washer over holding coil stud "B" and fasten with nut.

Fasten silver contact screw to insulator with a flat washer and nut. Insert terminal "A" and a lock washer over silver contact screw and fasten with nut. Insert assembly into end bell and fasten with four screws (E), fig. 25.

(8) Install clutch lever and fasten with pin and clip. Fasten solenoid to bracket with four screws and lock washers.

(9) Engage clutch with groove in control shaft and with clutch lever assembly. Slip shifter shaft through control lever assembly and clutch, and into control shaft.

Note. Flat on shifter shaft must be parallel with mounting surface of body when clutch tooth is engaged with groove in control shaft.

Slip washer and spacer over shifter shaft.

(10) Install packing in groove in cap and press bearing into cap with dust seal facing out. Assemble cap to body with three screws and lock screws with lock wire.

(11) Install control rod assembly and fasten with pins and clips. Slip linkage levers, with long side facing out, on shafts and fasten with screws and nuts.

(12) Lubricate bearings in body and cap assembly, clutch shaft, bushings, and pins with lubricant prescribed on lubrication order (TM9–718).

b. Assemble Gunner's Control Link Assembly (figs. 1 and 106). Drop springs and ball seats into bodies and slip ball screws through holes in sides of bodies. Replace adjusting screws and cotter pins. Replace lock nuts and ball joint assemblies on links. Press bushing into lever. Slip spacer into bushing and fasten to bracket with plain washer, lock washer, and screw. Assemble ball joint and link assemblies to lever and fasten with nuts.

c. Assemble Commander's Control (figs. 7, 27, and 132).

(1) Pack bearings with lubricant prescribed on lubrication order (TM9–718).

(2) Assemble handle-centering spring to spring-centering shaft (*a*(4) above).

(3) If necessary, press new needle bearings into housing. Slip shaft into housing with spring stop screws on same side of spring ears as pins in shaft.

(4) Install receptacle assembly and gasket and fasten with four screws and lock washers. Fasten cables to terminals of switch and install switch in handle with two screws and gaskets. Install diaphragm and plate, and fasten with four screws.

(5) Assemble lever to handle with pin and install retaining ring with snap ring pliers (41–P–1992–27) (fig. 109). Place spring in depression in handle and attach end of lever with limit screw (fig. 108).

(6) Slip handle over protruding end of spring-centering shaft and drive pin into handle and shaft. Loosen lock nuts and adjust spring stop screws so handle has no free radial movement.

d. Assemble Commander's Flexible Control Cable (fig. 111). Screw lock nuts and rod ends onto control cable, and lock rod ends with lock nuts.

46. Test Before Installation

a. Push solenoid plunger in and check if clutch engages with commander's control lever. If possible, connect solenoid to 24-volt power source and check operation of solenoid and clutch.

b. Twist gunner's shifter control lever to both sides of neutral and check for any free movement of lever unopposed by centering spring. Adjust screws (par. 45*a* (6)). Also, move commander's control handle to both sides of neutral and check for any free movement of handle unopposed by centering spring. Adjust screws (par. 45*c* (6)).

Section VII. REBUILD OF OIL RESERVOIR

47. Disassembly

a. General. Refer to paragraph 27*a*.

b. Disassemble High-Pressure Relief Valve (figs. 8, 28, 112, and 113). Unscrew upper hexagon relief valve cap stamped "1." Lift out shims, spacer retainer, relief valve spring, spring guide, and relief valve plunger. If plunger sticks in bushing, insert a No. 8–32 screw in end of plunger to pull it out of bushing, or remove pipe plug on opposite side of reservoir, below valve seat, and tap out plunger with a 3/16-inch rod.

c. Disassemble Gear Pump Relief Valve (figs. 8, 28, 112, and 113). Unscrew lower hexagon relief valve cap stamped "2." Lift out shims, spacer retainer, relief valve spring, spring guide, and relief valve plunger. If plunger sticks in bushing, insert a No. 8–32 screw in end of plunger to pull it out of bushing, or remove pipe plug on opposite side of reservoir, below valve seat, and tap out plunger with a 3/16-inch rod.

d. Remove Relief Valve Bushings and Seats. If it is necessary to replace either the high-pressure or gear pump relief valve plunger bushings and seats, remove socket head pipe plug below each seat. Place reservoir in an arbor press, insert a 3/8-inch diameter rod in drilled hole, and force taper bushing and taper seat out of cap end. Bushings and seats usually are damaged in removal from oil reservoir and must be replaced.

e. Remove Inspection Cover and Bayonet-Type Gage (figs. 8 and 112). Remove 10 inspection cover mounting screws. Lift off

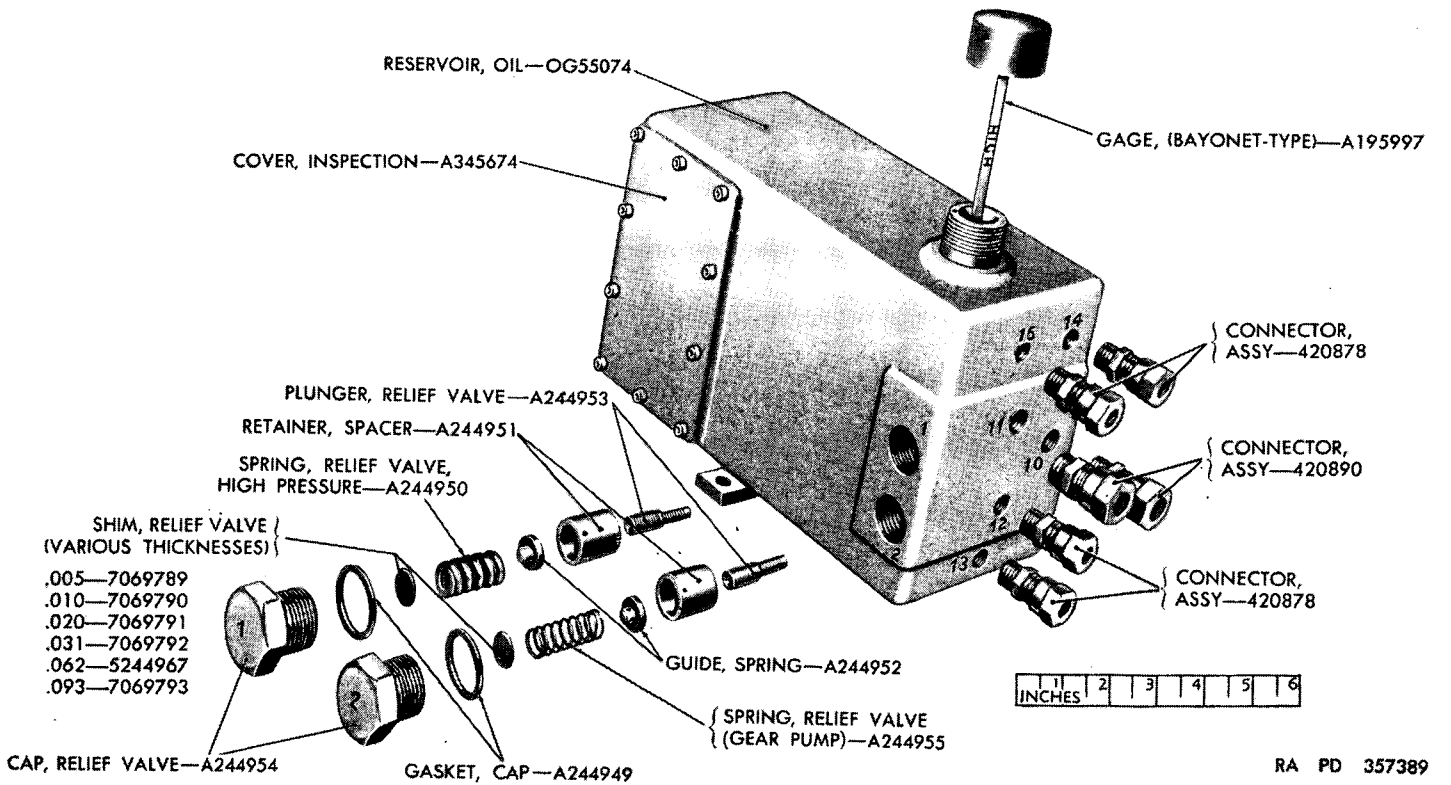


Figure 112. Relief valves in oil reservoir, exploded view.

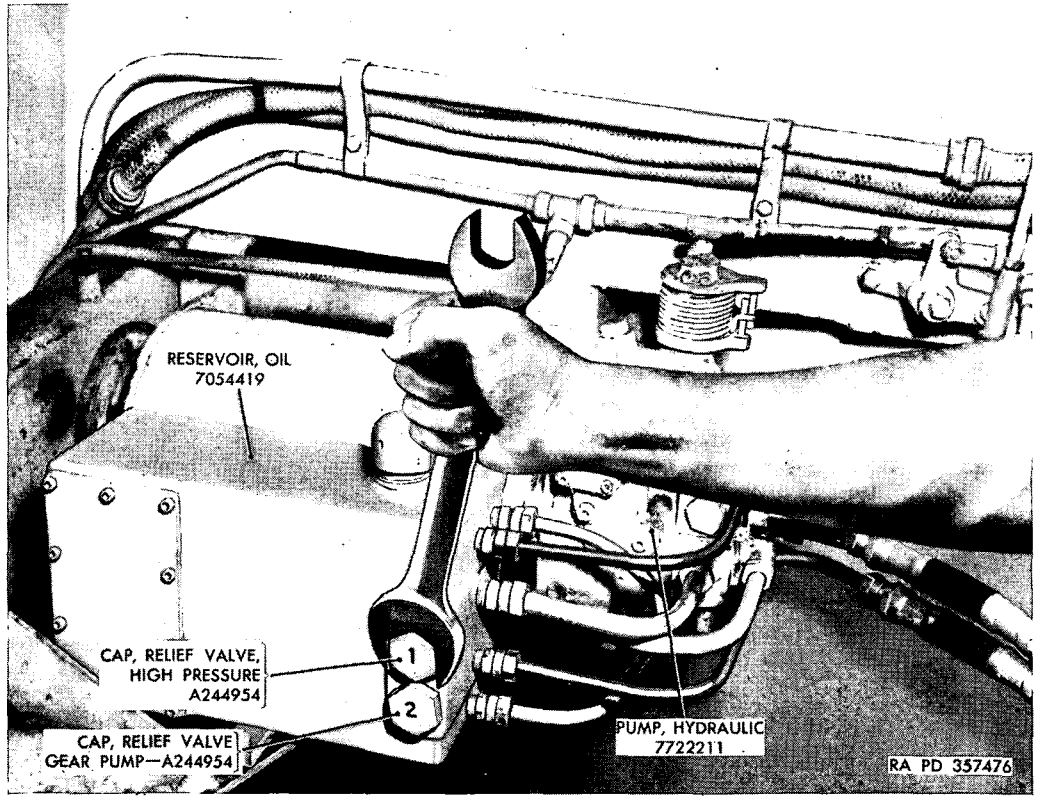


Figure 113. Removing radial piston pump relief valve cap.

inspection cover and gasket. Remove cover for inspection and cleaning purposes only. Turn breather cap counterclockwise. Unlock retaining ring in breather cap to remove bayonet-type level gage and felt.

Note. Do not turn or remove tube fittings unless joints leak or fittings must be replaced.

48. Cleaning

Wipe out oil reservoir with a lint-free cloth to remove all foreign sediment. Wipe off cover and strainer. Flush parts with dry-cleaning solvent or volatile mineral spirits paint thinner. Dry out excess solvent or paint thinner with compressed air.

49. Inspection and Repair

a. INSPECTION.

(1) *Inspect plungers.* Check for scoring marks, worn spots, and for dirty or gummy grooves and surfaces. Check sizes and fits (par. 72).

(2) *Inspect relief valve bushings and seats.* Look for worn or scored surfaces by removing pipe plugs and holding a service light near holes.

(3) *Inspect relief valve springs.* Check for broken or fatigued springs. Test both springs for proper length and force (par. 72).

b. REPAIR.

(1) *Lap plungers.* If plungers stick in bushings, lap plungers into bushings and seats with fine ground pumice and light lubricating oil. Flush out all pumice with dry-cleaning solvent or volatile mineral spirits paint thinner. Dry out excess solvent or paint thinner with compressed air. Coat surfaces with hydraulic oil.

(2) *Replace relief valve bushings and seats.* Refer to paragraph 72.

(3) *Replace defective springs or plungers.* Refer to paragraph 72.

50. Assembly

a. GENERAL. Refer to paragraph 27*a* before proceeding with assembly. Use new gaskets to avoid leaks.

b. ASSEMBLE RELIEF VALVE BUSHINGS AND SEATS (figs. 28 and 133). Insert small end of tapered seat into hole, put oil reservoir in arbor press, and force seat down with a ½-inch diameter rod to dimension shown on figure 133. Insert small end of tapered plunger bushing into hole and force bushing down with a ¾-inch diameter rod to dimension shown in figure 133. Screw socket head pipe plugs into place

below seats. Insert spacer retainers into holes with small hole end on plunger bushing.

c. Assemble High-Pressure Relief Valve (figs. 8, 28, and 133). Insert the high-pressure relief valve plunger into bushing in upper hole. If necessary, lap plunger in place (par. 49). Place convex surface of spring guide on plunger and heavy relief valve spring on guide. Slip new or annealed copper gasket on cap. Insert shims between top of spring and counterbore in cap. With gasket in place, screw the hexagon cap stamped "1" securely to oil reservoir.

d. Assemble Gear Pump Relief Valve (figs. 8, 28, and 133). Insert the gear pump relief valve plunger into bushing in lower hole. If necessary, lap plunger in place (par. 49). Place convex surface of spring guide on plunger and light relief valve spring on guide. Slip new or annealed copper gasket on cap. Insert shims between top of spring and counterbore in cap. With gasket in place, screw the hexagon cap stamped "2" securely to oil reservoir.

e. Assemble Inspection Cover and Bayonet-Type Gage (figs. 8, 112, and 133). Fasten gasket and inspection cover to oil reservoir with 10 screws. Insert felt washer into breather cap. Slip retaining ring and bayonet-type gage assembly into place in breather cap. Insert gage into oil strainer nipple and screw breather cap onto nipple.

51. Test Before Installation

Refer to paragraphs 63 and 64.

Section VIII. REBUILD OF TUBING, HOSES, AND FITTINGS

52. Disassembly

a. General. Refer to paragraph 27*a*.

b. Tubing (figs. 9, 10, 29, and 115). Sleeves and nuts of connection fittings remain on all tubes removed. Do not remove sleeves and nuts from tubes.

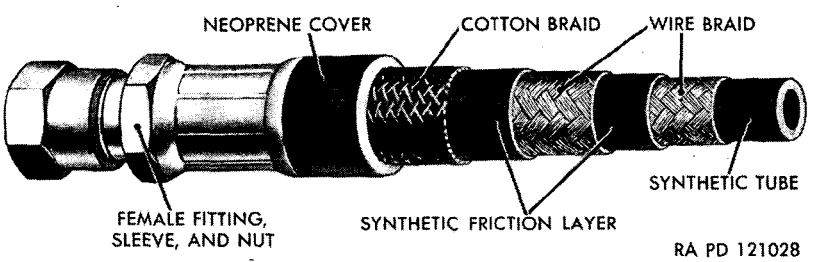


Figure 114. Hose assembly.

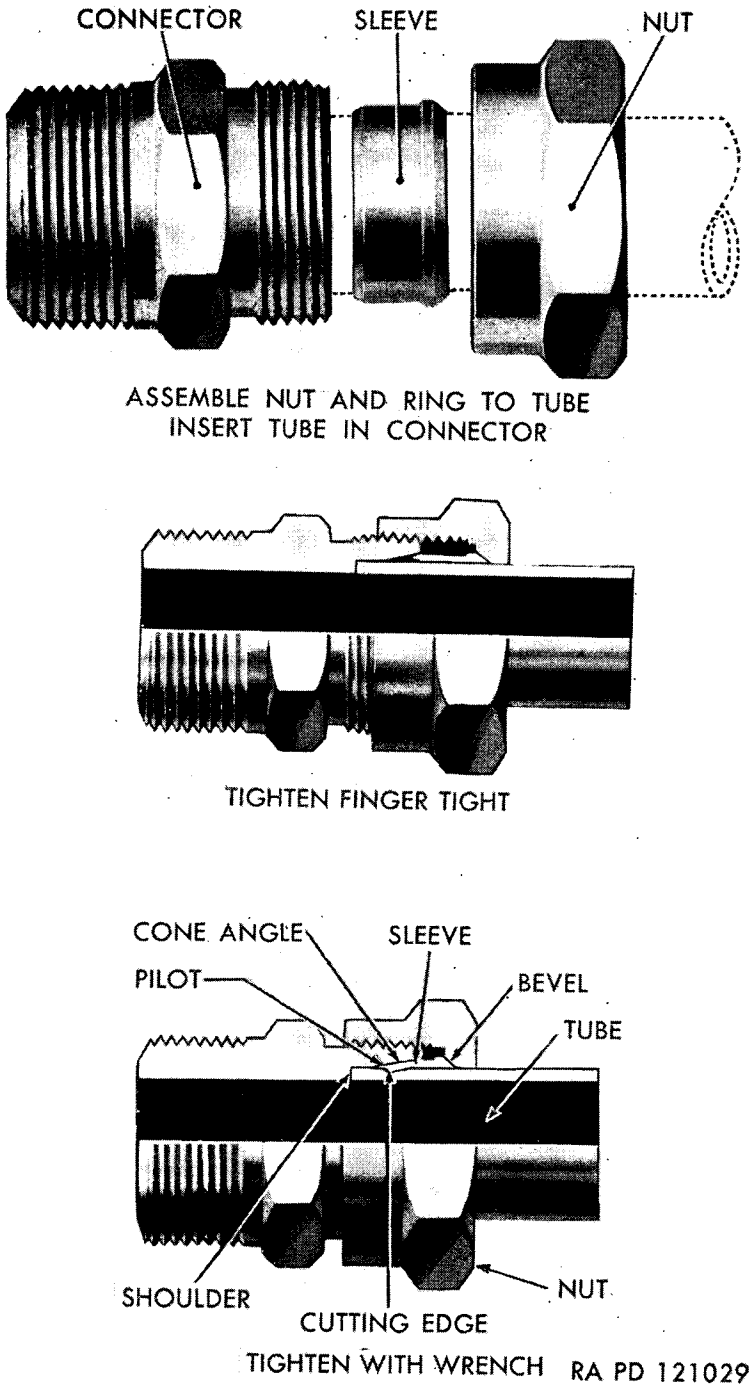


Figure 115. Removal or installation of fittings.

c. HOSES (figs. 9, 10, 29, and 114). Couplings are integral with hoses and should not be removed.

d. FITTINGS (fig. 115). Refer to paragraph 20*c*. Turn connector, elbow, or tee fittings counterclockwise to remove them from components.

53. Cleaning

Blow tubes, hoses, and fittings clean with compressed air. Wipe ends clean and avoid entrance of lint or pulp. Flush inside with dry-cleaning solvent or volatile mineral spirits paint thinner. Dry excess solvent or paint thinner with compressed air. Flush inside with hydraulic oil.

54. Inspection and Repair

a. INSPECTION.

(1) *Tubing.* Check for kinks, fractures, and separation of tube wall. Both ends must be square and burred both inside and outside.

(2) *Hoses.* Check for loose couplings, defective coupling threads, and cracked, peeling, soft, or spongy hose.

(3) *Fittings.* Check for cracked bodies or defective threads. Chech for cracked nuts or defective threads. Be sure sleeve is tight on tube.

b. REPAIR.

(1) *Tubing.* If found defective, replace with new tubing (pars. 53 and 55).

(2) *Hoses.* If found defective, replace with new hose assemblies (pars. 53 and 55).

(3) *Fittings.* If found defective, replace with new fittings (pars. 53 and 55). When nuts or sleeves are defective it is necessary to replace tubing also.

55. Assembly

a. GENERAL. Refer to paragraph 27*a* before proceeding with assembly.

b. TUBING (fig. 115). Slide nut and then the sleeve on tube. Be sure sleeve is not on backwards. Head of sleeve must be towards nut. Insert tube end into fitting. Be sure tube is bottomed on fitting shoulder. Lubricate with oil. Turn nut with wrench until it *feels tight.* (If convenient, bring nut down on sleeve and make nut finger tight on fittings. Tighten nut about one and one-half turns; never more than two turns.) In reassembly, pull nut up finger tight and then tighten nut about one-eighth turn. Do not overtighten nut.

c. HOSES (fig. 114). Insert tube ends into couplings and tighten nuts (*b* above).

d. FITTINGS (fig. 115). Use liquid-type gasket cement, or similar materials sparingly on pipe threads of fittings. Be sure to keep these materials out of the hydraulic system. Never use shellac. Turn fittings clockwise until tight. Tee and elbow fittings must point in the same direction as fittings removed. Fasten nut, sleeve, and tube (*b* above).

Section IX. INSTALLATION OF HYDRAULIC TURRET TRAVERSING MECHANISM INTO TURRET

56. General

a. PREPARATION. It is not necessary to remove turret from vehicle to install turret traversing mechanism. All operations can be performed while working in turret basket. Depress barrel of 90-mm gun to its extreme position. Be sure traversing motor switch is in "OFF" position and turret traversing lock engaged. Clean inside of basket and the individual components. before starting to install units.

b. TUBE INSTALLTION PRECAUTIONS. Before installing any tube, check tag wired to tube for port numbers to be connected to each end. Remove cloth or paper covers from ends of tubes. Be sure no lint or pulp is left in tubes. Install tubes in accordance with instructions given in paragraph 55.

57. Installation of Two-Way Variable-Delivery Hydraulic Pump (figs. 2, 9, 10, 29, and 30)

a. INSTALL HYDRAULIC PUMP (fig. 30). Set coupling in slot of electric drive motor shaft. Line up tongue on drive coupling with slot in hydraulic pump shaft. Position hydraulic pump on electric motor (figs. 1 and 116). Be sure coupling did not drop off drive motor shaft. Fasten hydraulic pump to motor with four bolts and secure with lock wire.

b. INSTALL TUBES AND HOSES (figs. 9, 10, and 29). Refer to paragraphs 55 and 56. Connect nut, sleeve, and tube to elbow fitting in hydraulic pump port 5. Connect nut, sleeve, and other end of tube to connector fitting in oil reservoir port 14. Connect nut, sleeve, and tube to elbow fitting in hydraulic pump port 3. Connect nut, sleeve, and other end of tube to connector fitting in oil reservoir port 13. Connect nut, sleeve, and tube to elbow fitting in hydraulic pump port 4. Connect nut, sleeve, and other end of tube to a tee fitting. Connect nut, sleeve, and tube to elbow fitting in hydraulic locking cylinder port 16. Connect nut, sleeve, and other end of tube to tee fitting. Connect nut, sleeve, and tube to elbow fitting in hydraulic pump port 2. Connect nut, sleeve, and other end

of tube to hose assembly. Connect nut, sleeve, and tube to elbow fitting in hydraulic motor port 2. Connect nut, sleeve, and other end of tube to open end of hose assembly. Connect nut, sleeve, and tube to elbow fitting in hydraulic motor port 2. Connect nut, sleeve, and other end of tube to open end of hose assembly. Connect nut, sleeve, and tube to elbow fitting in hydraulic pump port 1. Connect nut, sleeve, and other end of tube to hose assembly. Connect nut, sleeve, and tube to elbow fitting in hydraulic motor port 1. Connect nut, sleeve, and other end of tube to open end of hose assembly. Connect nut, sleeve, and tube to connector fitting in oil reservoir port 12. Connect nut, sleeve, and other end of tube to tee fitting leading to hydraulic pump port 4 and hydraulic locking cylinder port 16. Connect nut, sleeve, and tube to elbow fitting in hydraulic pump port 2. Connect nut, sleeve, and other end of tube to connector fitting in oil reservoir port 10. Connect nut, sleeve, and tube to elbow fitting in hydraulic pump port 1. Connect nut, sleeve, and other end of tube to connector fitting in oil reservoir port 11. Connect nut, sleeve, and tube to connector fitting in oil reservoir port 15. Connect nut, sleeve, and other end of tube to tee fitting in hydraulic locking cylinder port 17.

c. INSTALL CONTROL LINK AND CABLE (fig. 30). Connect link assembly to hydraulic pump control lever with lock nut.

d. FILL SYSTEM WITH OIL (figs. 1, 8, and 117). Be sure oil and container used to fill system are clean. Hydraulic cleanliness cannot be overemphasized. Remove filler cap from top of oil reservoir. Pour all hydraulic oil into reservoir through filler cap nipple. Assemble filler cap to reservoir nipple. Test operation of hydraulic traversing mechanism (TM 9–718), and inspect all connections for leaks.

e. ADJUST FOR CONTROL SHAFT NEUTRAL POSITION (fig. 116). Refer to TM 9–718 for hydraulic pump starting instructions. To adjust control shaft position, remove lock wire on the two screws in hydraulic pump control lever. If turret creeps clockwise, loosen right-hand screw about one-quarter turn outward and tighten the left-hand screw inward the same amount. If turret creeps counterclockwise, loosen left-hand screw about one-quarter turn outward and tighten the right-hand screw inward the same amount. Adjust screws until neutral position is reached. Be sure both screws are tight against control shaft. Replace lock wire.

58. Installation of Constant-Displacement Hydraulic Motor (figs. 3, 9, and 10)

a. INSTALL TRAVERSE MOTOR. Tap Woodruff key into keyway in input drive gear assembly of traversing gear mechanism. Lift hydraulic motor, with coupling in place, into motor mounting bracket and over shaft end of drive gear. Be sure Woodruff key remains in

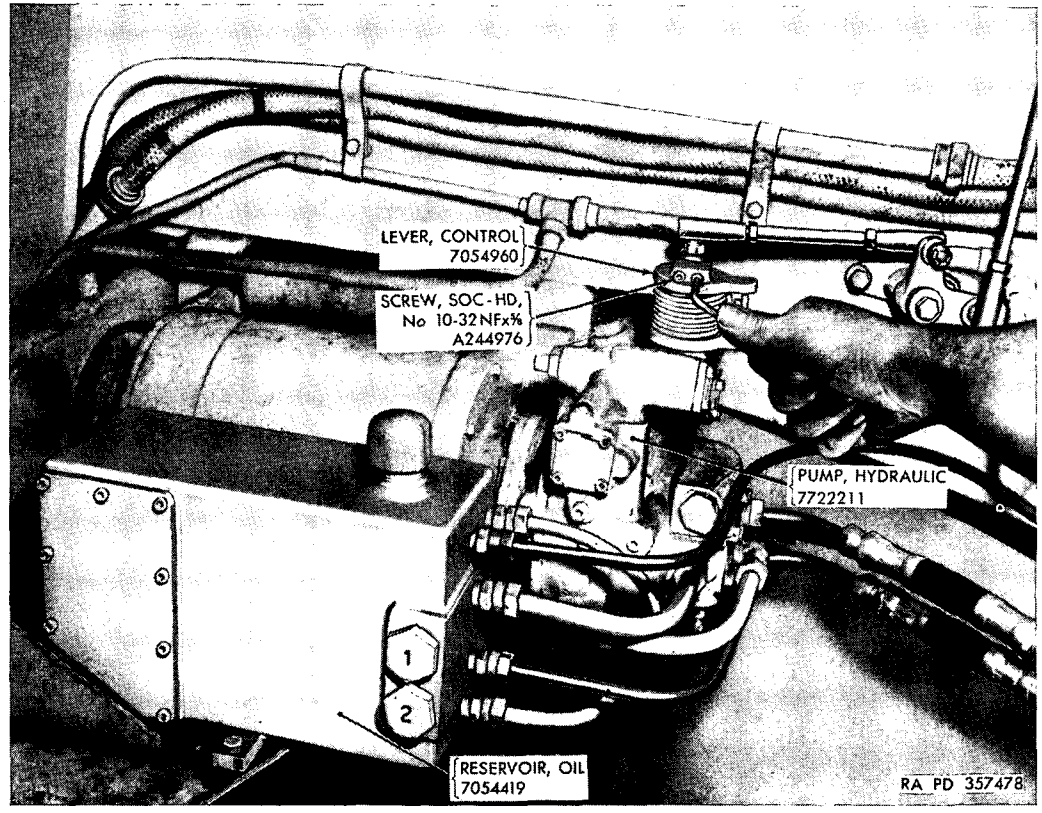


Figure 116. Adjusting hydraulic pump control shaft for neutral position.

place. Position traverse motor on bracket (figs. 1, 4, 5, and 31). Fasten hydraulic motor to bracket with four bolts and lock nuts.

b. Install Tubes and Hoses. Refer to paragraphs 55 and 56. Connect nut, sleeve, and tube to elbow fitting in hydraulic motor port 3. Connect nut, sleeve, and other end of tube to tee fitting in hydraulic locking cylinder port 17. Connect nut, sleeve, and tube to elbow fitting in hydraulic motor port 2. Connect nut, sleeve, and other end of tube to hose assembly. Connect nut, sleeve, and tube to elbow fitting in hydraulic pump port 2. Connect nut, sleeve, and other end of tube to open end of hose assembly. Connect nut, sleeve, and tube to elbow fitting in hydraulic motor port 1. Connect nut, sleeve, and other end of tube to hose assembly. Connect nut, sleeve, and tube to elbow fitting in hydraulic pump port 1. Connect nut, sleeve, and other end of tube to open end of hose assembly.

c. Fill System With Oil. Refer to paragraph 57*d*.

59. Installation of Turret Traversing Gear Mechanism

(figs. 4, 5, and 30)

a. Install Traverse Gear Mechanism. Insert the two bolts with washers through the vertical mounting lugs on gear housing. Slip shims and spacers over bolts and lift assembly into position (fig. 30). Screw bolts in place. Insert split cone-shaped washers on the short and long screws, and fasten housing at output-gear end to turret. Test rotation of turret by operating the hand-crank handle. If output gear binds on ring gear, add or remove shims under vertical mounting bosses to bring output gear teeth parallel with ring gear teeth.

b. Install Traverse Motor on Traverse Gear Mechanism. Refer to paragraph 58. Also connect nut, sleeve, and tube to elbow fitting in hydraulic locking cylinder port 16. Connect nut, sleeve, and other end of tube to tee fitting leading to hydraulic pump port 4 and oil reservoir port 12.

c. Install Gunner's Control on Traverse Gear Mechanism. Refer to paragraph 60*a*.

60. Installation of Gunner's and Commander's Controls

(figs. 6, 7, 25, 26, 27, 30, and 32)

a. Install Gunner's Control (fig. 32). Fasten gunner's shifter control assembly to top of gear traversing mechanism with four screws. Lock screws with wire. Fasten cover to top of gunner's shifter control with two nuts, two screws, and two washers. Connect link assembly from bracket and lever assembly to lever on shifter shaft with one lock nut. Connect commander's flexible cable rod end to lever on gunner's shifter control pin assembly with screw and

nut. Insert cable into receptacle assembly on solenoid assembly and fasten with nut.

b. Install Bracket, Lever Assembly, and Control Links (figs. 1, 10, and 106). Fasten bracket to turret with two bolts and washers. Slip lock washer, plain washer, spacer, and lever assembly on bolt, and fasten bolt and spacer to bracket. Connect one link assembly to lever assembly on bracket and lever on hydraulic pump control with lock nut. Connect other link assembly to lever assembly on bracket and lever on shifter shaft with lock nut.

c. Test for Neutral Position. Refer to paragraph 57*e*.

d. Install Commander's Control (figs. 7, 27, and 32). Fasten commander's control to ceiling of turret with three screws and nuts. Fasten two plates to turret, each with two screws and four washers. Place lower and upper halves of two sets of blocks around control cable and fasten blocks to plates with four screws, washers, and nuts. Screw a nut and rod end on each end of control cable. Fasten one rod end to commander's control lever with screw and nut, and other rod end to lever on gunner's shifter control pin assembly with screw and nut. Insert cable into receptacle assembly on commander's control assembly and fasten with nut. Adjust rod ends and locking nuts so that control lever will be in neutral position when released.

e. Test for Neutral Position. Refer to paragraph 57*e*.

61. Installation of Oil Reservoir

(figs. 8 and 30)

a. Install Oil Reservoir. Position the reservoir on bracket, and fasten together with three screws, nuts, and washers.

b. Install Tubes. Refer to paragraphs 55 and 56. Connect nut, sleeve, and tube to connector fitting in oil reservoir port 14. Connect nut, sleeve, and other end of tube to elbow fitting in hydraulic pump port 5. Connect nut, sleeve, and tube to connector fitting in oil reservoir port 13. Connect nut, sleeve, and other end of tube to elbow fitting in hydraulic pump port 3. Connect nut, sleeve, and tube to connector fitting in oil reservoir port 12. Connect nut, sleeve, and other end of tube to tee fitting leading to hydraulic pump port 4 and hydraulic locking cylinder port 16. Connect nut, sleeve, and tube to connector fitting in oil reservoir port 10. Connect nut, sleeve, and other end of tube to elbow fitting in hydraulic pump port 2. Connect nut, sleeve, and tube to connector fitting in oil reservoir port 11. Connect nut, sleeve, and other end of tube to elbow fitting in hydraulic pump port 1. Connect nut, sleeve, and tube to connector fitting in oil reservoir port 15. Connect nut, sleeve, and other end of tube to tee fitting in hydraulic locking cylinder port 17.

c. Fill System With Oil. Refer to paragraph 57*d*.

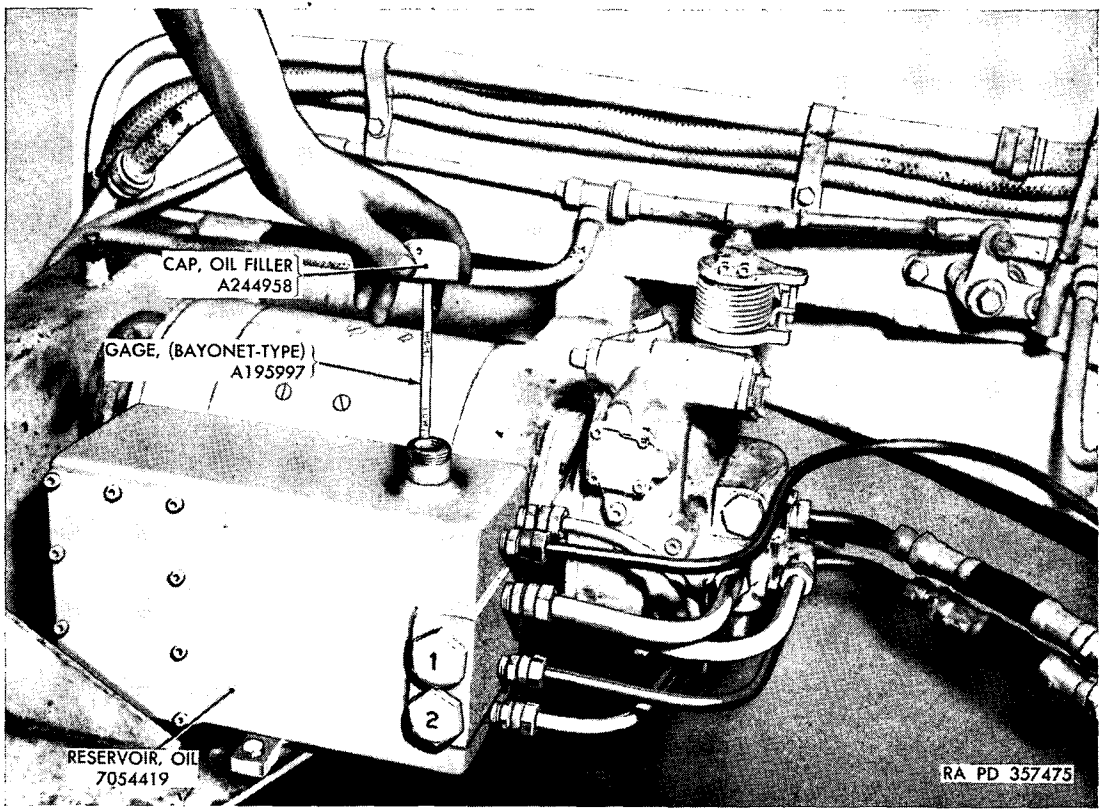


Figure 117. Checking oil level in oil reservoir.

62. Installation of Tubing, Hoses, and Fittings

(figs. 9–10, 29, and 30)

a. Installation of Tubing, Hoses, and Fittings. Refer to paragraph 55.

b. Fill System With Oil. Refer to paragraph 57*d*.

CHAPTER 5

TEST OF HYDRAULIC TURRET TRAVERSING MECHANISM

Section I. TEST IN SHOP

63. General

Conventional tests, inspections, and possible adjustments of rebuilt turret traversing mechanisms can be conveniently made on the test stand (figs. 118 and 119) before being installed in the vehicle. Gages provide direct reading of gear pump pressure and radial piston hydraulic pump pressure. Speeds of hydraulic pump and output speeds of hydraulic motor can be read on a tachometer. Torque tests for clockwise and counterclockwise rotation of hydraulic motor shaft, when facing end of shaft, can be made with the prony brake. Inspection of leaks, abnormal noises, and unit malfunctioning—together with control, relief valve, and other adjustments—can easily be made.

64. Procedure

a. Preparation for Testing Units (figs. 118–120).

(1) *Mount hydraulic pump on electric motor.* Set drive coupling that connects hydraulic pump shaft to electric motor shaft in slot in end of electric motor shaft. Line up slot in pump drive shaft with coupling on end of electric motor drive shaft. Position pump on electric motor, making sure that drive coupling is engaged. Install four electric motor flange mounting screws and lock washers while holding pump to electric motor flange.

(2) *Mount hydraulic motor on bracket.* Fasten hydraulic-motor mounting bracket to test stand. Fasten hydraulic motor to bracket with four screws. Refer to figures 118 and 119 for position of tube fittings. Set Woodruff key in keyway on hydraulic motor shaft, slip pulley on shaft, and fasten pulley to shaft with set screw. Do not assemble prony bracket until hydraulic pump and hydraulic motor load test (*c*(4) below).

(3) *Fasten oil reservoir to test stand.* Fasten oil reservoir to top of test stand with three cap screws and remove oil filler cap.

(4) *Install tubing.* Refer to paragraph 55. Connect hydraulic-pump port 3 to oil reservoir port 13. Connect pump port 4 to tee leading to cross below gage 1. Connect this tee to oil reservoir port 12. Connect pump port 15 to a position above oil filler nipple. Connect left-hand pump port 1 to oil reservoir port 11. Connect front elbow fitting in pump port 2 to oil reservoir port 10. Connect elbow fitting in pump port 1 to tee leading to gage 2. Connect this tee to hydraulic motor port 1. Connect elbow fitting in pump port 2 to tee leading to gage 3. Connect this tee to hydraulic motor port 2. Plug fittings in ports 14 and 15 in reservoir.

(5) *Fill oil reservoir with oil.* Pour one gallon of hydraulic oil into oil reservoir. Be sure oil and container are clean and that no foreign matter enters the oil reservoir when filling and testing equipment.

b. Fill the Hydraulic Pump, Hydraulic Motor, and Tubing With Oil (figs. 118 through 120). Close the globe valves below the two high-pressure gages 2 and 3. Open the globe valve below gear pump pressure gage 1. Switch the electric motor on and off a few times to circulate the oil through the system. This method of starting will assure adequate lubrication and prevent damage to the closely fitted working parts. Check the gear pump pressure on gage No. 1. When the low-pressure gage No. 1 needle moves from zero as the pump is started, the gear pump is delivering oil to the system, and the electric motor can be run continuously. When the gear pump pressure reaches 40 psi or more, move hydraulic pump control lever slowly counterclockwise until full stroke is reached and hydraulic motor pulley rotates full speed in a clockwise direction when facing end of shaft. Then move hydraulic pump control lever slowly clockwise until full stroke is reached and hydraulic motor pulley rotates full speed in a counterclockwise direction when facing end of shaft. Run pump at least for a few minutes and actuate control lever in each direction so as to operate motor and thereby replace all air in the system with a solid column of oil. The gear pump relief valve in the oil reservoir is set at 75 psi by the manufacturer.

c. Testing and Inspecting Components in Operation (figs. 118 through 122).

(1) *Check hydraulic pump for full stroke in each direction.* Check for equal overtravel of control lever when at full-stroke position in each direction. Start hydraulic pump and turn control lever slowly clockwise until the maximum hydraulic motor shaft speed is reached. The point when maximum hydraulic motor speed is reached can be determined by

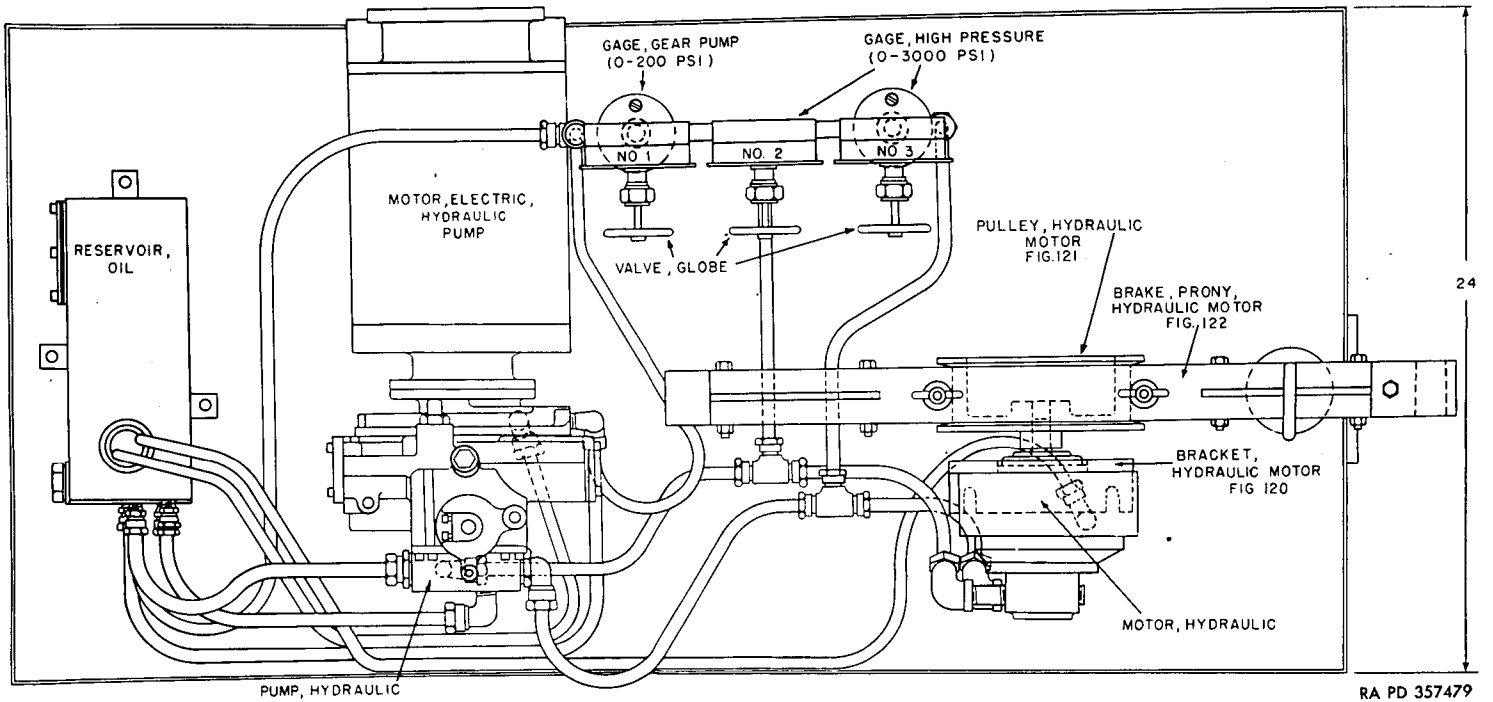


Figure 118. Plan view of test stand.

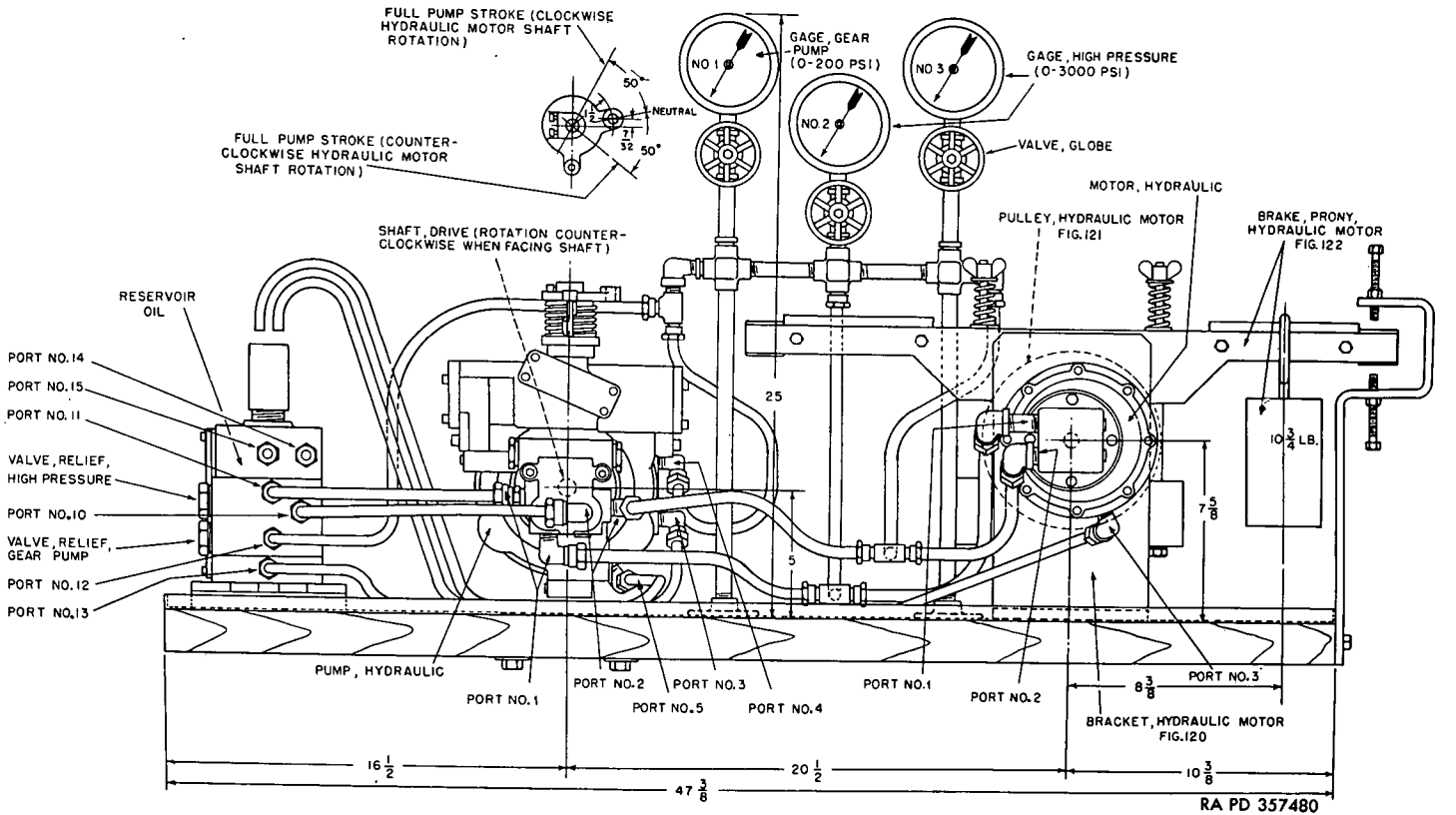
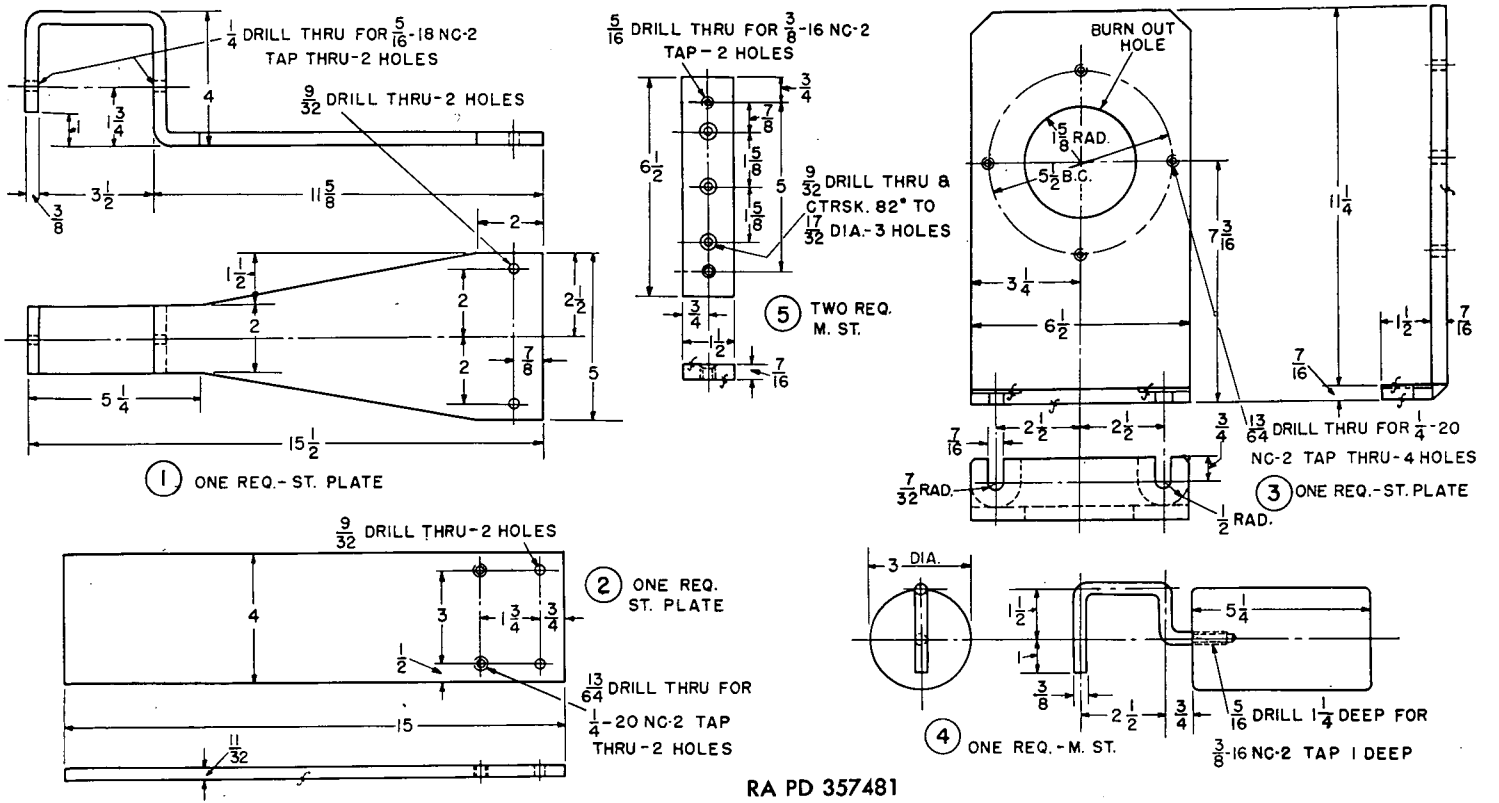


Figure 119. Side view of test stand.



RA PD 357481

Figure 120. Details of bracket and prony-brake parts for mounting hydraulic motor.

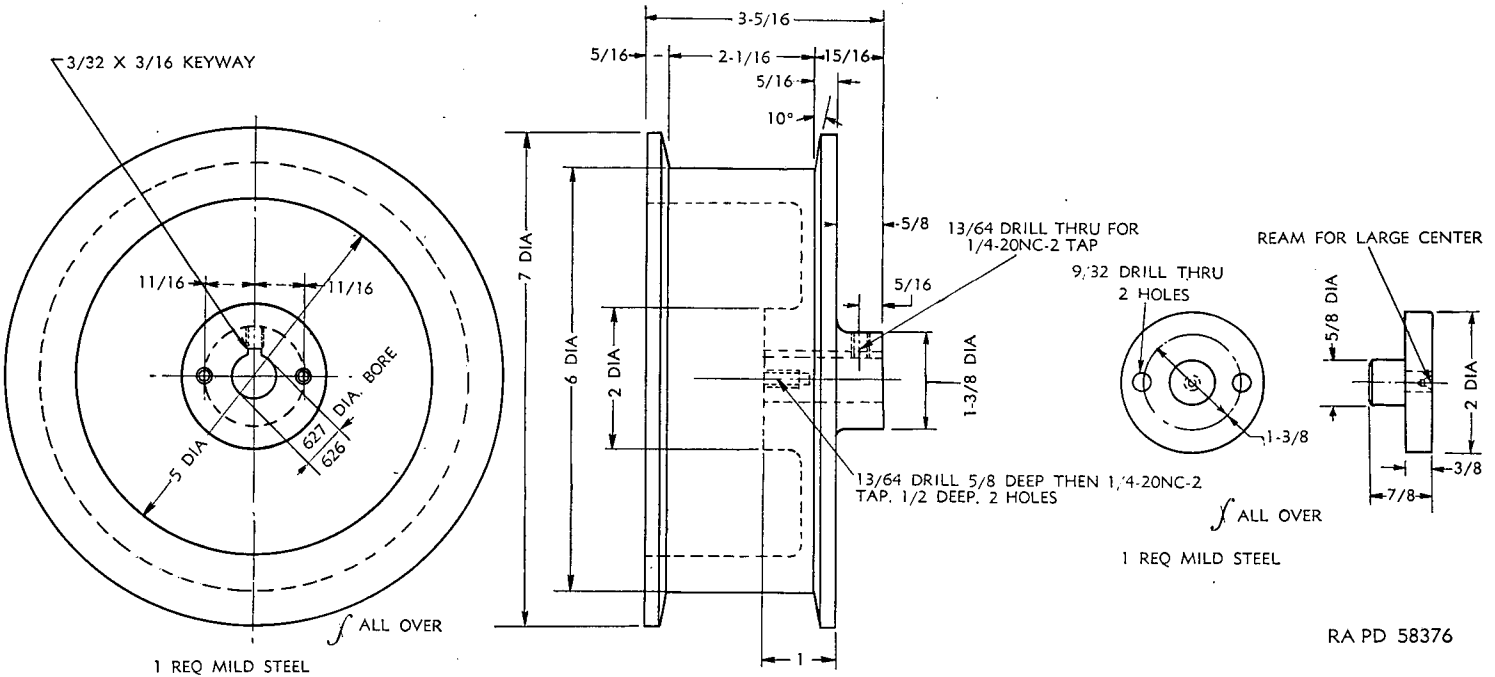


Figure 121. Details of pulley and cover for hydraulic-motor test.

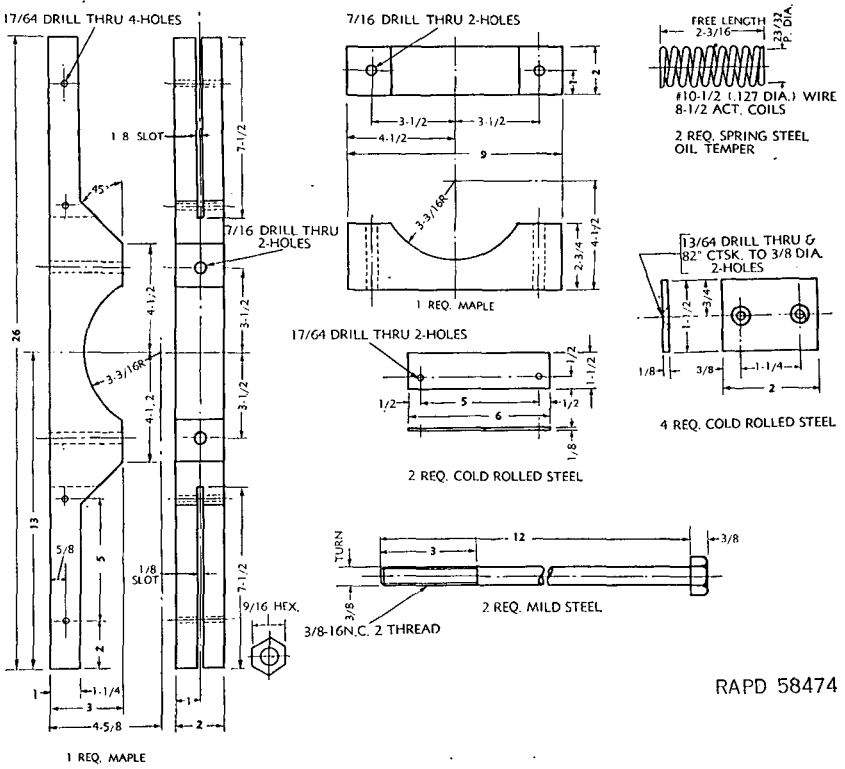


Figure 122. Details of prony brake for hydraulic-motor test.

the hum of the hydraulic motor or with the tachometer. Measure the distance of control lever travel from this point to the maximum stop position of control lever in the clockwise direction. Make the same control lever test for counterclockwise rotation. If there is any difference in the control lever overtravel, correct by adjusting the large set screw in the equalizer bar (figs. 44 and 126). Remove equalizer bar cover lock wire and four screws. Lift off cover and gasket.

CAUTION: Oil will run out of this opening during the test, so provide a trough to return the oil to reservoir, or arrange to add hydraulic oil to reservoir to prevent the system from running dry.

Loosen the small lock set screw in equalizer bar. Turn the large set screw in equalizer bar in or out slightly and make additional control lever tests until the full stroke overtravel is equalized in each direction. Tighten down the small lock set screw. Assemble equalizer bar cover and gasket to pump case with four screws. Recheck the maximum output speed of hydraulic motor shaft in each direction with a tachometer.

If the difference in speed exceeds 150 rpm, reset position of slide block race with control cam back-up roller screw. Loosen the control can back-up roller screw slightly (fig. 127), and recheck output speeds of hydraulic-motor shaft. If the difference in speed is decreased, turn screw outward until the speeds are approximately the same, or within 150 rpm. Measure distance screw has been loosened from case, remove screw and grind an equivalent amount off end of screw. Assemble screw to case and recheck hydraulic motor output shaft speeds (par. 15). If loosening the control-cam back-up screw increases the difference in hydraulic motor speeds, replace the screw with a longer one. As an alternative, file a small amount off face of boss on pump case.

CAUTION: Stuff a clean rag into the tapped hole to prevent iron filings from entering system. Use a magnetized rod to remove all filings in hole.

Assemble screw securely in place and again test hydraulic motor speeds (par. 15). If necessary, file additional material off face of screw boss.

(2) *Check neutral position of hydraulic-pump control handle.* Hydraulic motor shaft should not rotate when pump control handle is in neutral position. Turn lever clockwise to full stroke and then release it. Check to see if hydraulic motor shaft stops. Turn lever counterclockwise and make same check. If hydraulic motor shaft does not stop, remove wire from the two adjusting screws on pump control handle, and turn right-hand screw outward (fig. 116), and the left-hand screw inward if hydraulic motor shaft rotates clockwise when facing end of shaft. Turn left-hand screw outward and right-hand screw inward if hydraulic motor shaft rotates counterclockwise when facing end of shaft. Tighten both screws against control shaft and insert new lock wire. Recheck maximum output speeds of hydraulic motor (par. 15).

(3) *Check control action.* Turn control lever quickly clockwise to full stroke to see if hydraulic motor shaft accelerates to full speed quickly. Release lever for neutral position test. Turn handle quickly counterclockwise for same test. Turn lever quickly from full stroke in one direction to full stroke in the other direction to see if hydraulic motor shaft rotation reverses quickly. If reversal of hydraulic motor shaft rotation is sluggish, check gear pump pressure ((7) below).

(4) *Hydraulic pump and motor load test.* Wipe all units clean and dry for observing joint leaks. Install prony brake onto hydraulic-motor pulley. Set weight on right-hand side of

prony brake arm 8¾ inches from center of hydraulic motor. Open globe valves beneath high-pressure gages No. 2 and No. 3. Turn pump control lever counterclockwise to full stroke and gradually tighten down wing nuts on prony brake until arm is centered and hydraulic motor exerts a torque of 90 lb-in. At this torque, pressure gage No. 3 should register between 1,100 and 1,200 psi. Check electric motor and hydraulic motor shaft speeds. Hydraulic motor speed is normally 100 to 300 rpm less than electric motor. Turn pump control lever clockwise to full stroke, set weight on left-hand side of prony-brake arm, and make the same tests as described above.

(5) *Slip tests.* Make slip tests of pump and motor while conducting the load tests. Turn pump control lever clockwise to half stroke, or less, and adjust prony brake for 90 lb-in torque. Set can of 1- to 4-cubic-inch capacity under drain line from motor port 3 to oil reservoir and measure the time required to fill slip can. Normal slip of a new motor is from 10 to 40 cubic inches per minute. Set slip can under line from pump port 5 to oil reservoir and measure time required to fill slip can. Normal slip of a new pump is 12 to 60 cubic inches per minute. Turn pump lever counterclockwise to half stroke or less and make same tests as described above. Usually, the hydraulic motor and hydraulic pump will operate satisfactorily with a slip of 100 to 120 cubic inches per minute. If there is a radical difference between the two hydraulic motor slip readings or the slip is excessive, inspect (par. 34*a*(3) and (6)). If the pump slip is excessive when control is in neutral, inspect flat valve (par. 29*a*(3)), inspect gear pump gears (par. 29*a*(9)) and pilot valve (par. 29*a*(10)).

(6) *High-pressure relief valve setting.* Tighten down the wing nuts on prony-brake arm until hydraulic-motor shaft pulley cannot turn. Start hydraulic pump and slowly turn control lever clockwise to full stroke and note relief valve setting on gage No. 3. Release lever to neutral position. Turn control lever counterclockwise to full stroke and note relief valve setting on gage No. 2. The normal relief valve setting is between 1,000 and 1,600 psi. To increase or decrease the relief valve setting, add or remove shims between spring and hexagonal relief valve cap No. 1 (nearest top of reservoir). A shim of 0.005-inch thickness increases the pressure setting approximately 150 to 170 psi (par. 14).

(7) *Gear pump pressure relief valve setting.* Release wing nuts on prony brake. Turn pump control lever to full stroke in either direction and note relief valve setting in gage No. 1.

The normal relief valve setting is 75 psi. To increase or decrease the relief valve setting, add or remove shims between spring and hexagonal relief valve cap No. 2 and oil reservoir. A shim of 0.010-inch thickness increases the pressure setting approximately 2 to 2½ psi (par. 14).

(8) *Leakage inspection.* Carefully examine all gaskets, screws, fittings, oil seals, and castings for possible leaks. All units should remain clean and dry throughout load tests. Tightening screws and fittings usually remedies incidental leaks. If oil seals or castings leak, new parts are usually necessary.

Section II. TEST IN THE VEHICLE

65. Starting the Equipment

Refer to paragraph 61, TM 9–718.

66. Tests and Inspections

a. Speed Tests. Place a mark on turret and a coinciding mark on vehicle. With tank on level ground, turn gunner's or commander's control handle clockwise to full strike and check speed of turret. Turn gunner's or commander's control handle counterclockwise to full stroke and check speed of turret. Maximum turret speed is 4¼ rpm. If turret speed is low in one direction, check as per paragraph 11.

b. Neutral Test. With tank on level ground, turn gunner's or commander's control handle to full stroke in one direction and release handle to see if turret stops when control reaches neutral. Make same test when moving control handle in the opposite direction. If turret creeps when control handle is in neutral position, adjust control (par. 57*e*).

c. Leakage Inspection. Carefully examine all units for oil leaks. Units should remain clean and dry throughout speed tests.

d. Check Oil Levels. Check oil level in hydraulic pump oil reservoir. Add hydraulic oil, if necessary.

CHAPTER 6
SERVICEABILITY STANDARDS

67. General

The serviceability standards included herein give the minimum, maximum, and key clearances of new or rebuilt parts as well as wear limits which indicate that point to which a part or parts may be worn before replacement, in order to receive maximum service with minimum replacement. Normally, all parts which have not been worn beyond the dimensions shown in the "Wear limits" column or damaged from corrosion will be approved for service. An asterisk (*) in the "Wear limits" column indicates that the part or parts should be replaced when worn beyond the limits given in the "Sizes and fits of new parts" column.

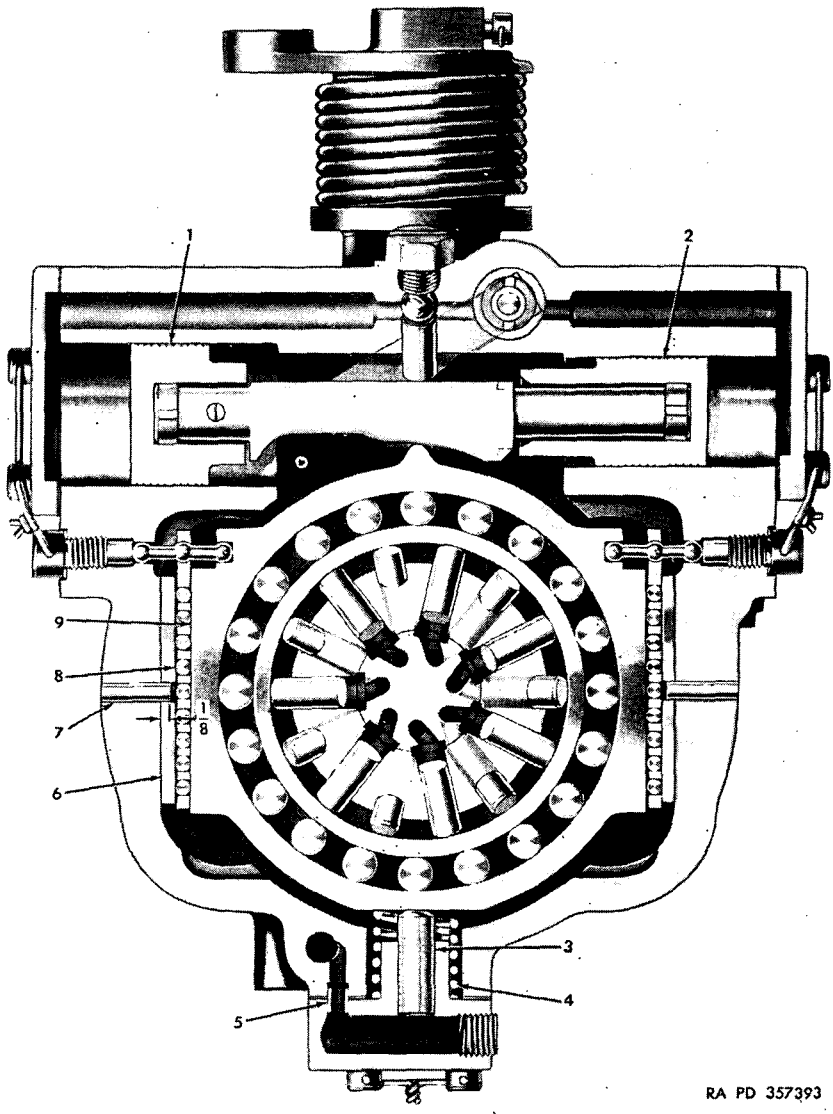


Figure 123. Serviceability standards points of measurement for hydraulic pump.

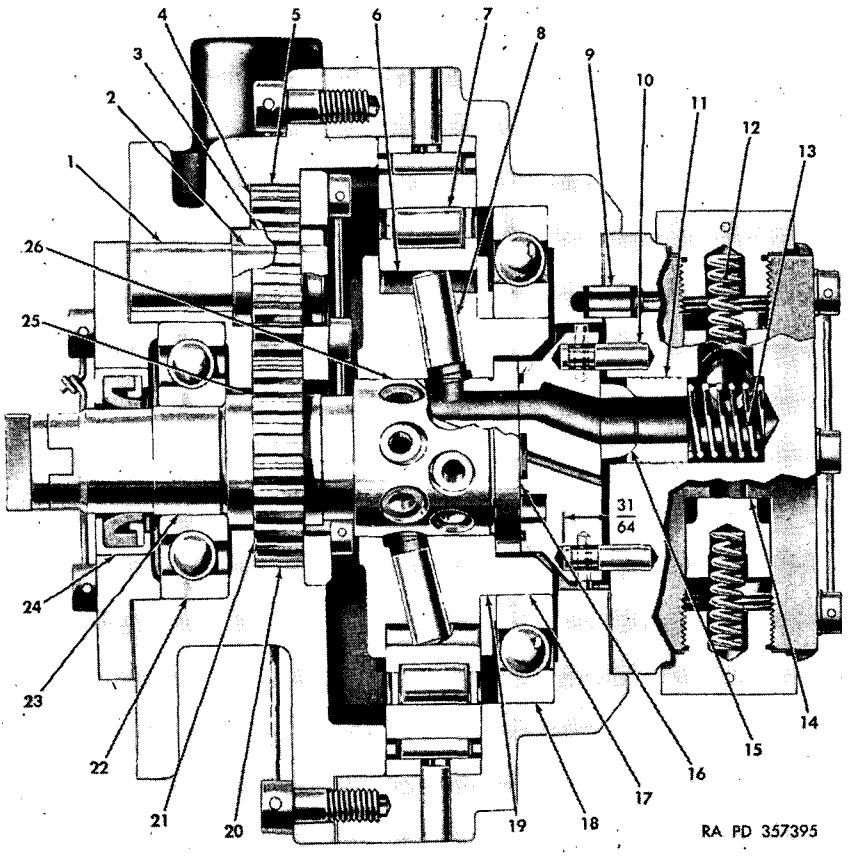


Figure 124. Serviceability standards points of measurement for hydraulic pump.

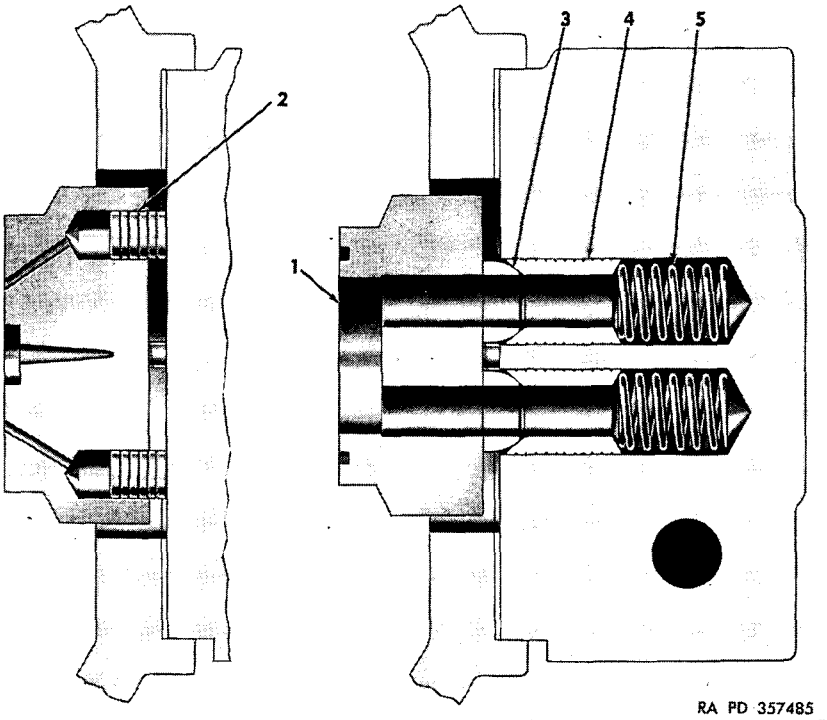


Figure 125. Serviceability standards points of measurement for end head and flat valve.

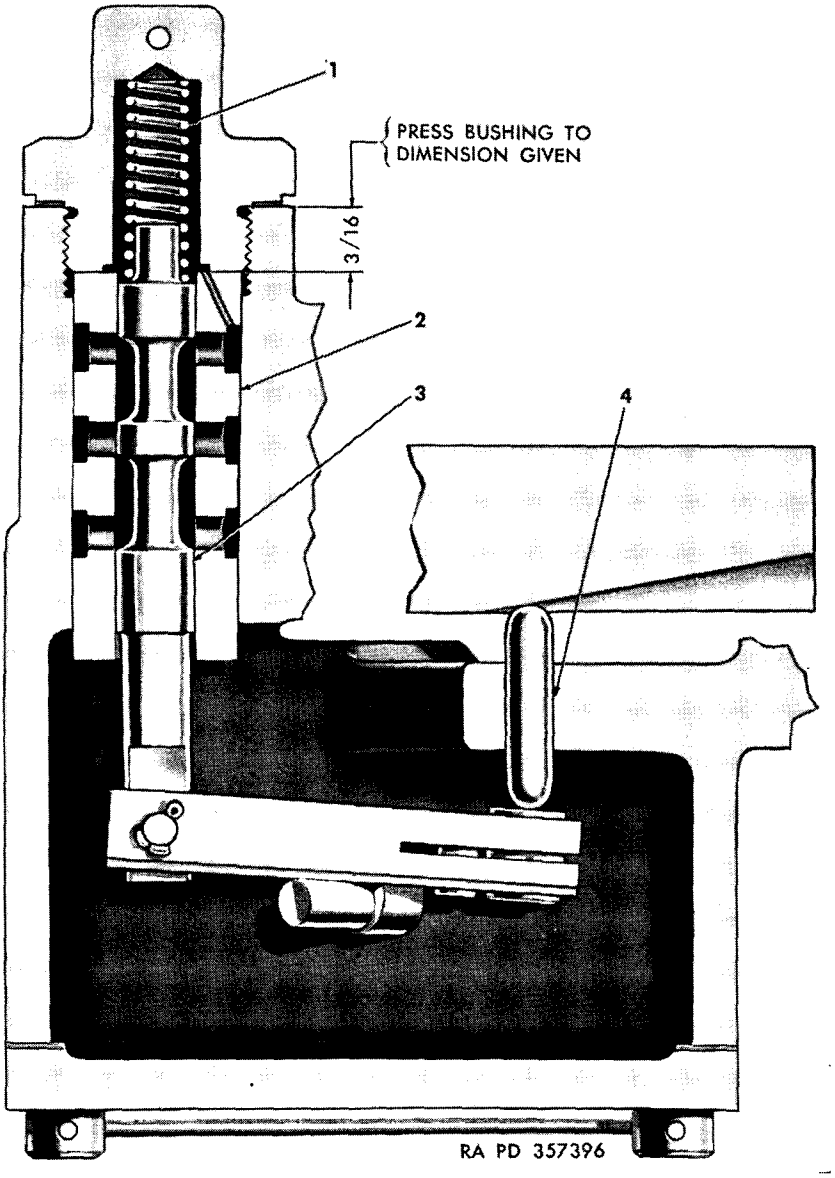


Figure 126. Serviceability standards points of measurement for control pilot valve plunger.

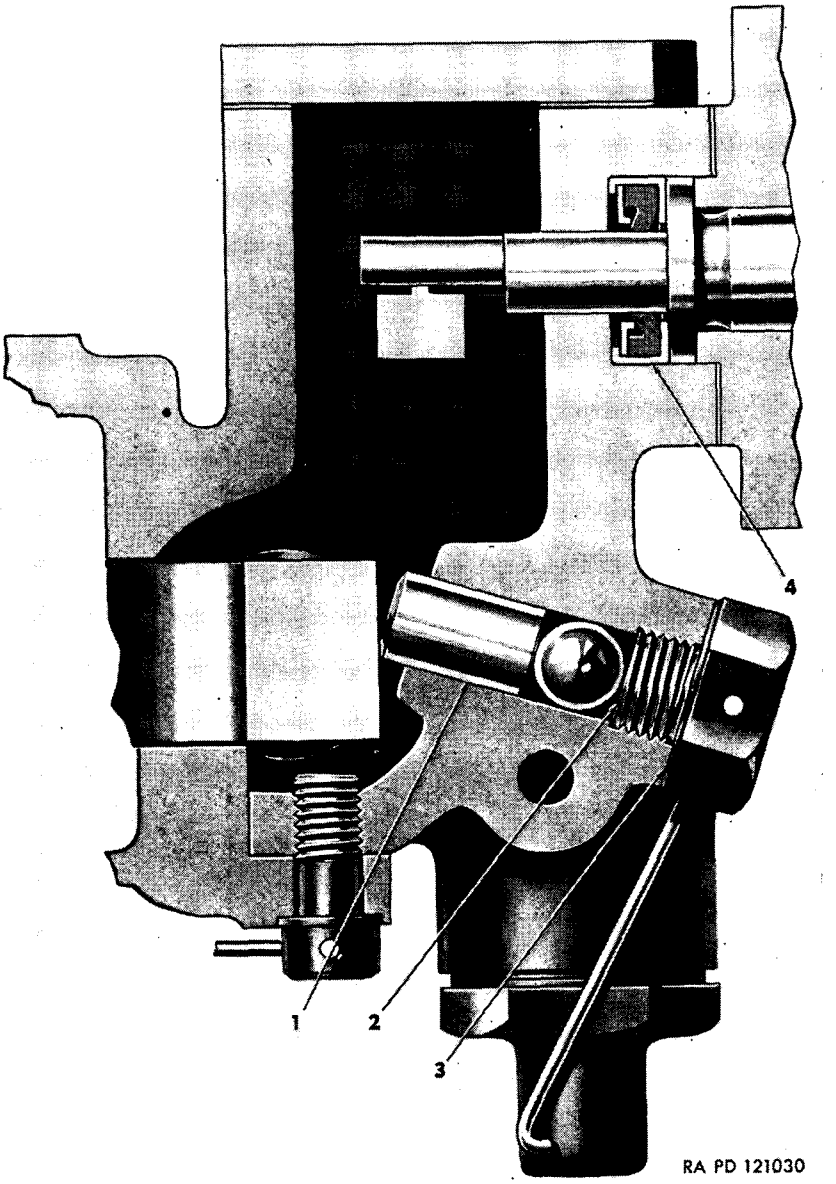


Figure 127. Serviceability standards points of measurement for control cam back-up roller.

68. Two-Way Variable-Delivery Hydraulic Pump

(ch. 4, Sec. III).

a. Slide Block Back-up Cylinder Assembly.

(1) *Slide block back-up piston.*

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
123	3	Outside diameter	0.4372 to 0.4374 in.	(*)
123	3	Diameter of bore in cylinder	0.4375 to 0.4378 in.	(*)

Note. Select for 0.0003- to 0.0006-inch sliding fit.

(2) *Slide-block back-up spring.*

123	4	Free length (approximate)	1 19/32 in.	
123	4	Length under 34- to 37-lb load	2 5/32 in.	2 3/32 in. at 34-lb. load.

(3) *Slide block back-up cylinder connector.*

123	5	Outside diameter	0.2495 to 0.2500 in.	(*)
123	5	Diameter of bore in cylinder	0.2495 to 0.2500 in.	(*)
123	5	Diameter of bore in housing	0.2495 to 0.2500 in.	(*)

b. Slide Block and Bearings.

(1) *Slide block.*

123	9	Distance across flats	5.248 to 5.250 in.	(*)
124	7	Inside diameter	4.6270 to 4.6280 in.	(*)

Note. Bore must be free of pits and grooves. Select for 0.001- to 0.002-inch diametral roller clearance when assembled to roller bearing assembly.

(2) *Thrust roller bearing.*

124	6	Inside diameter	3.561 to 3.562 in.	(*)

Note. Bore of inner race must be free of pits and grooves. See note above.

(3) *Caged roller bearing.*

123	8	Diameter of rollers	0.1560 to 0.1562 in.	(*)

(4) *Case liner.*

123	6	Thickness	0.1557 to 0.1562 in.	(*)

Note. Shim for 0.001- to 0.003-inch total clearance between case liners, caged roller bearings, and slide block.

(5) *Slide block liner pin.*

123	7	Outside diameter	0.1870 to 0.1875 in.	(*)
123	7	Diameter of bore in housing	0.186 to 0.187 in.	(*)

Note. Press into case until pin protrudes 1/8 inch as shown.

c. Control Piston and Cam Assembly.

(1) *Large control piston.*

123	1	Outside diameter	1.6237 to 1.6240 in.	(*)
123	1	Diameter of bore in case	1.6250 to 1.6255 in.	(*)

Note. Select for 0.0010- to 0.0015-inch loose fit.

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		(2) *Small control piston.*		
123	2	Outside diameter	1.2490 to 1.2493 in.	(*)
123	2	Diameter of bore in case	1.2500 to 1.2505 in.	(*)

Note. Select for 0.0010- to 0.0013-inch loose fit. Slide block bearing surface of cam must be smooth and free of grooves.

		(3) *Control cam back-up roller.*		
127	1	Outside diameter	0.4370 to 0.4372 in.	(*)
127	1	Diameter of bore in case	0.4375 to 0.4380 in.	(*)

Note. Select for 0.0005- to 0.0010-inch running fit.

127	2	Grind off end of screw to obtain absolute zero pump stroke with control cam accurately centered in pump case. (See par 64*c*(1)).		
127	3	File off top of boss to obtain absolute zero stroke with control cam accurately centered in pump case. (See par 64*c*(1)).		
		(4) *Control shaft oil seal.*		
127	4	Outside diameter	0.750 to 0.751 in.	(*)
127	4	Diameter of bore in pump case	0.750 to 0.751 in.	(*)

Note. Wiping edge of seal must be sharp, firm, and free of cracks or cuts.

d. GEAR PUMP.

		(1) *Gear pump drive gear.*		
124	20	Outside diameter	1.603 to 1.604 in.	(*)
124	20	Diameter of bore in housing	1.6055 to 1.6060 in.	(*)
124	21	Width of gear	0.3740 to 0.3755 in.	(*)
124	21	Depth of bore in housing	0.3750 to 0.3760 in.	(*)
124	25	Diameter of drive shaft at gear area.	0.9365 to 0.9370 in.	(*)
124	25	Diameter of bore in gear	0.9375 to 0.9380 in.	(*)
124	20	Backlash with driven gear	0.008 to 0.010 in.	(*)

Note. Check for broken, scored, or worn teeth. Lap for 0.001- to 0.002- in total side clearance.

		(2) *Gear pump driven gear.*		
124	5	Outside diameter	1.3440 to 1.3450 in.	(*)
124	5	Diameter of bore in housing	1.3465 to 1.3470 in.	(*)
124	4	Width of gear	0.3740 to 0.3755 in.	(*)
124	4	Depth of bore in housing	0.3750 to 0.3760 in.	(*)
124	2	Diameter of stub shaft at bushing area.	0.4990 to 0.4995 in.	(*)
124	2	Diameter of bore in bushing	0.5000 to 0.5005 in.	(*)
124	3	Diameter of bore in gear	0.6870 to 0.6875 in.	(*)
124	3	Outside diameter of bushing	0.6885 to 0.6890 in.	(*)
124	5	Backlash with drive gear	0.008 to 0.010 in.	(*)

Note. Check for broken, scored, or worn teeth. Lap for 0.001- to 0.002- in total side clearance.

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		(3) *Stub shaft.*		
124	1	Outside diameter	0.5007 to 0.5010 in	(*)
124	1	Diameter of bore in housing	0.4999 to 0.5002 in	(*)
		e. DRIVE SHAFT BEARING.		
124	22	Outside diameter	2.0466 to 2.0472 in	(*)
124	22	Diameter of bore in housing	2.0475 to 2.0481 in	(*)
124	23	Inside diameter	0.7870 to 0.7874 in	(*)
124	23	Diameter of shaft at bearing area	0.7873 to 0.7877 in	(*)
		f. OIL SEAL.		
124	24	Outside diameter	1.3770 to 1.3810 in	(*)
124	24	Diameter of bore in cover	1.3740 to 1.3760 in	(*)
		Note. Wiping edge of seal must be sharp, firm, and free of cracks or cuts.		
		g. CYLINDER, PISTON, AND DRIVE SHAFT ASSEMBLY.		
124	8	Diameter of pistons	0.4051 to 0.4061 in	(*)
124	8	Diameter of bores in cylinder	0.4054 to 0.4064 in	(*)
		Note. Select and lap for 0.0003- to 0.0010-in clearance.		
124	16	Shaft flat and plane within	0.0002 in	(*)
		Note. Edges of ports must be sharp and free of cracks. Bridge between ports must not be scored.		
124	26	Inside diameter, small end	1.4995 to 1.500 in	(*)
124	26	Diameter of drive shaft, small end.	1.5015 to 1.5025 in	(*)
124	26	Inside diameter, large end	1.5070 to 1.5075 in	(*)
124	26	Diameter of drive shaft, large end	1.5091 to 1.5101 in	(*)
		Note. Scratch marks on cylinder and drive shaft must be in line. Shaft, cylinder, and pistons will be replaced as a unit.		
		h. FLAT VALVE AND END HEAD ASSEMBLY.		
		(1) *Valve locating pin.*		
124	10	Outside diameter	0.1870 to 0.1875 in	(*)
124	10	Diameter of bore in end head	0.1865 to 0.1870 in	(*)
		Note. Press into end head until pin protrudes $3\frac{1}{64}$ in, as shown.		
		(2) *Large back-up psiton.*		
124	11	Outside diameter	0.7645 to 0.7655 in	(*)
124	11	Diameter of bore in end head	0.7648 to 0.7658 in	(*)
		Note. Select for 0.0003- to 0.0010-in clearance.		
124	15	Lap tumbler with piston.		
		(3) *Large back-up piston spring.*		
124	13	Free length (approximate)	1 in	
124	13	Length under 18.5- to 20.5-lb load	$\frac{3}{4}$ in	$2\frac{3}{32}$ in at 18.5-lb load.

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		(4) *Small back-up piston.*		
125	4	Outside diameter	0.5457 to 0.5467 in	(*)
125	4	Diameter of bore in end head	0.5460 to 0.5470 in	(*)
		Note. Select for 0.0003- to 0.0010-in clearance.		
125	3	Lap tumbler with piston.		
		(5) *Small back-up piston spring.*		
125	5	Free length (approximate)	7/8 in	
125	5	Length under 19.5- to 21.5-lb load.	5/8 in	19/32 in at 19.5-lb load
		(6) *Equalizer pistons.*		
125	2	Outside diameter	0.3112 to 0.3114 in	(*)
125	2	Diameter of bore in flat valve	0.3107 to 0.3117 in	(*)
		Note. Select and lap for 0.0003- to 0.0005-in clearance.		
		(7) *Flat valve.*		
125	1	Flat and plane within	0.0002 in	
		Note. Edges of crescents must be sharp. Bridges between crescents must not be scored.		
		(8) *End head connector.*		
124	9	Outside diameter	0.2495 to 0.2500 in	(*)
124	9	Diameter of bore in end head	0.2495 to 0.2500 in	
124	9	Diameter of bore in housing	0.2495 to 0.2500 in	
		(9) *Check valve spring.*		
124	12	Free length (approximate)	1 13/32 in	
124	12	Length under 4.8- to 5.2-lb load	1 in	7/8 in at 4.8-lb load.
		(10) *Check valve disk.*		
124	14	Flat and plane within	0.0002 in	
		Note. Lap on seat.		
		i. Cylinder Bearing.		
124	18	Outside diameter	4.5268 to 4.5276 in	(*)
124	18	Diameter of bore in case	4.5280 to 4.5290 in	
124	17	Inside diameter	2.5585 to 2.5591 in	(*)
124	17	Diameter of bearing area of cylinder.	2.5591 to 2.5596 in	
		j. Bearing Spacer Ring.		
124	19	Diameter of bore in ring	2.5580 to 2.5590 in	
124	19	Diameter of cylinder	2.5591 to 2.5596 in	

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
k. PUMP CONTROL PILOT VALVE ASSEMBLY.				
		(1) *Pilot valve spring.*		
126	1	Free length (approximate)	1 5/16 in	
126	1	Length under 2.89- to 3.18- lb load.	1 5/16 in	7/8 in at 2.89-lb load.
		(2) *Pilot valve bushing.*		
126	2	Outside diameter	0.6885 to 0.6890 in	(*)
126	2	Diameter of bore in case	0.6875 to 0.6880 in	(*)
Note. Press into case 3/16 in below surface as shown.				
		(3) *Pilot valve plunger.*		
126	3	Outside diameter	0.3114 to 0.3116 in	(*)
126	3	Diameter of bore in bushing	0.3117 to 0.3120 in	(*)
Note. Select and lap for 0.0003- to 0.0006-in clearance.				
		(4) *Follow-up pin.*		
126	4	Outside diameter	0.1860 to 0.1875 in	(*)
126	4	Diameter of bore in case	0.1875 to 0.1880 in	(*)
Note. Select for 0.0005- to 0.0020-in clearance.				

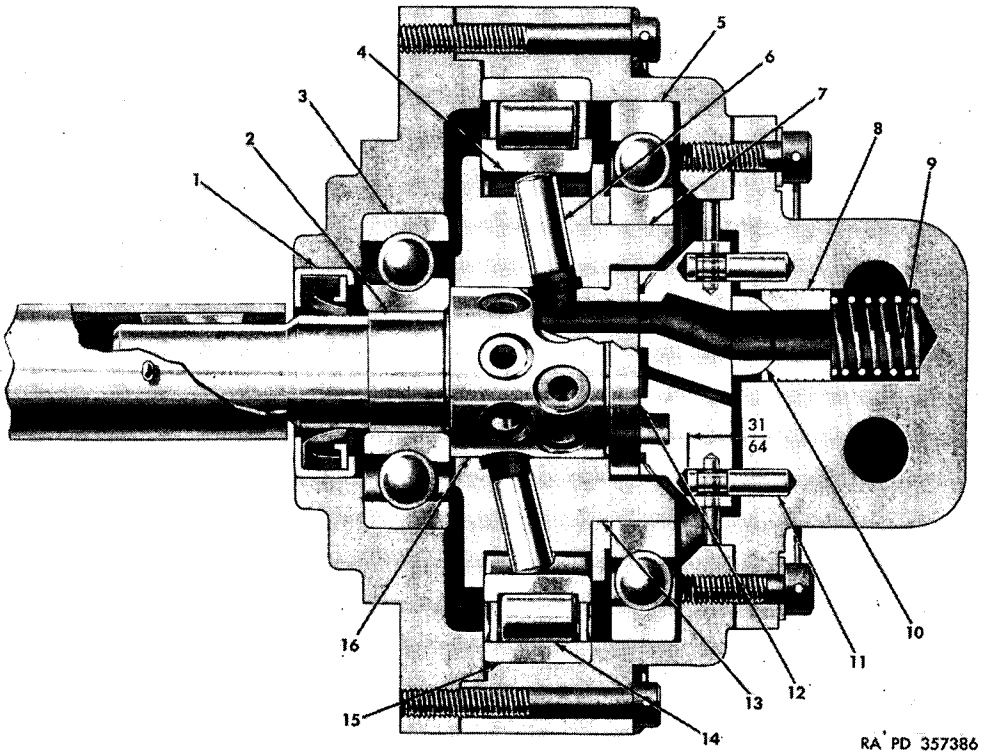


Figure 128. Serviceability standards points of measurement for hydraulic motor.

69. Constant-Displacement Hydraulic Motor

(Ch. 4, Sec. VII)

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		a. DRIVE SHAFT BEARING.		
128	3	Outside diameter	2.0467 to 2.0472 in	(*)
128	3	Diameter of bore in cover	2.0475 to 2.0481 in	(*)
128	2	Inside diameter	0.7870 to 0.7874 in	(*)
128	2	Diameter of drive shaft	0.7873 to 0.7877 in	(*)
		b. OIL SEAL.		
128	1	Outside diameter	1.377 to 1.381 in	(*)
128	1	Diameter of bore in cover	1.375 to 1.376 in	(*)
		Note. Wiping edge of seal must be sharp, firm, and free of cracks or cuts.		
		c. CYLINDER, PISTON, AND DRIVE SHAFT ASSEMBLY.		
128	6	Diameter of pistons	0.4051 to 0.4061 in	(*)
128	6	Diameter of bores in cylinder	0.4054 to 0.4064 in	(*)
		Note. Select and lap for 0.0003- to 0.0010-in clearance.		
128	12	Shaft plane and flat within	0.0002 in	(*)
		Note. Edges of ports must be sharp and free of cracks. Bridges between ports must not be scored.		
128	16	Inside diameter, small end	1.4995 to 1.5000 in	(*)
128	16	Diameter of drive shaft, small end.	1.5015 to 1.5023 in	(*)
128	16	Inside diameter, large end	1.5070 to 1.5075 in	(*)
128	16	Diameter of drive shaft, large end.	1.5091 to 1.5101 in	(*)
		Note. Scratch marks on cylinder and drive shaft must be in line. Shaft, cylinder, and pistons must be replaced as a unit.		
		d. FLAT VALVE AND END HEAD ASSEMBLY.		
		(1) *Valve locating pin.*		
128	11	Outside diameter	0.1870 to 0.1875 in	
128	11	Diameter of bore in end head	0.1865 to 0.1870 in	
		Note. Press into end head until pin protrudes $3\frac{1}{64}$ in, as shown.		
		(2) *Large back-up piston.*		
128	8	Outside diameter	0.7645 to 0.7655 in	(*)
128	8	Diameter of bore in end head	0.7648 to 0.7658 in	(*)
		Note. Select for 0.0003- to 0.0010-in clearance.		
128	10	Lap tumbler with piston.		
		(3) *Large back-up piston spring.*		
128	9	Free length (approximate)	1 in	
128	9	Length under 18.5- to 20.5-lb load.	$\frac{3}{4}$ in	$\frac{23}{32}$ in at 18.5-lb load.

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		(4) *Small back-up piston.*		
125	4	Outside diameter	0.5457 to 0.5467 in	(*)
125	4	Diameter of bore in end head	0.5460 to 0.5470 in	(*)
		Note. Select for 0.0003- to 0.0010-in clearance.		
125	3	Lap tumbler with piston.		
		(5) *Small back-up piston spring.*		
125	5	Free length (approximate)	⅞ in	
125	5	Length under 19.5- to 21.5-lb load.	⅞ in	$19\frac{3}{32}$ in at 19.5-lb load.
		(6) *Equalizer pistons.*		
125	2	Outside diameter	0.3112 to 0.3114 in	(*)
125	2	Diameter of bore in flat valve	0.3107 to 0.3117 in	(*)
		Note. Select and lap for 0.0003- to 0.0005-in clearance.		
		(7) *Flat valve.*		
125	1	Flat and plane within	0.0002 in	
		Note. Edges of crescents must be sharp. Bridges between crescents must not be scored.		
		e. Cylinder Bearing.		
128	5	Outside diameter	4.5268 to 4.5276 in	(*)
128	5	Diameter of bore in housing	4.5280 to 4.5290 in	(*)
128	7	Inside diameter	2.5585 to 2.5591 in	(*)
128	7	Diameter of cylinder at bearing area.	2.5591 to 2.5596 in	(*)
		f. Bearing Spacer Ring.		
128	13	Diameter of bore in ring	2.5580 to 2.5590 in	(*)
128	13	Diameter of cylinder	2.5591 to 2.5596 in	(*)
		g. Thrust Roller Bearing.		
128	15	Outside diameter	4.9992 to 5.0000 in	(*)
128	15	Diameter of bore in housing	5.0003 to 5.0010 in	(*)
128	14	Inside diameter of outer race	4.6280 to 4.6290 in	(*)
128	4	Diameter of bore in inner race	3.561 to 3.562 in	(*)
		Note. Bore of inner race must be smooth and free of pits and grooves.		

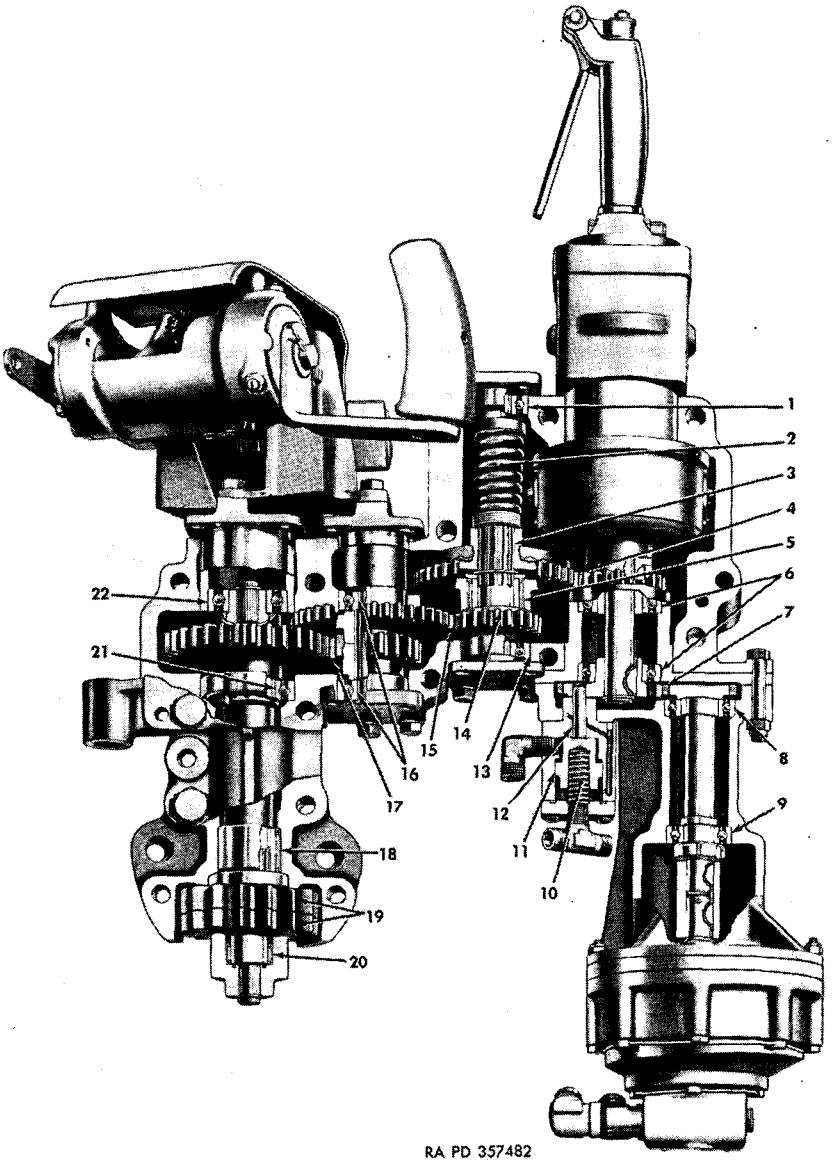


Figure 129. Serviceability standards points of measurement for traversing gear mechanism.

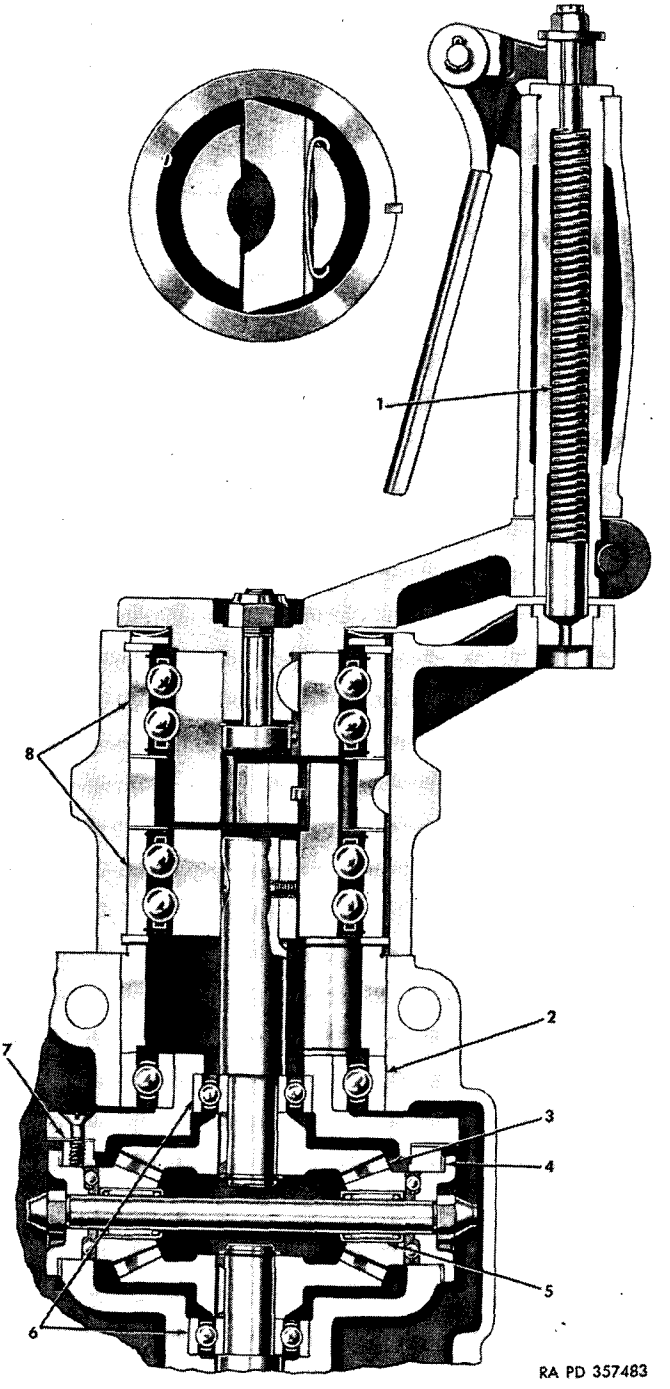


Figure 130. Serviceability standards points of measurement for manual drive and differential mechanism.

70. Traversing Gear Mechanism

(Ch. 4, sec. v.)

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		a. DIFFERENTIAL ASSEMBLY.		
		(1) *Differential cover bearing.*		
130	2	Outside diameter	2.9523 to 2.9528 in.	(*)
130	2	Diameter of bearing bore in housing.	2.9527 to 2.9532 in.	(*)
130	2	Inside diameter	1.7712 to 1.7717 in.	(*)
130	2	Diameter of cover hub	1.7716 to 1.7721 in.	(*)
		(2) *Differential shaft bearings.*		
130	6	Outside diameter	1.3775 to 1.3780 in.	(*)
130	6	Diameter of bearing bores in cover and carrier.	1.3779 to 1.3785 in.	(*)
130	6	Inside diameter	0.5903 to 0.5906 in.	(*)
130	6	Diameter of shafts at bearing area.	0.5905 to 0.5908 in.	(*)
		(3) *Pinion needle bearings.*		
130	5	Outside diameter	0.5620 to 0.5630 in.	(*)
130	5	Diameter of bore in pinions	0.562 to 0.563 in.	(*)
130	5	Diameter of pinion shaft at bearing area.	0.3745 to 0.3750 in.	(*)
		(4) *Differential bevel gears and pinions.*		
130	3	Backlash between gears and pinions.	0.001 to 0.003 in.	(*)
130	4	Shim per paragraph 40 *e*.		
130	7	Shim per paragraph 40 *c*.		
		(5) *Differential carrier gear.*		
129	4	Diameter over 0.1728-in rolls	2.4363 to 2.4883 in.	(*)
129	4	Backlash with clutch gear	0.001 to 0.003 in.	(*)
		(6) *Differential carrier and motor driven gear bearings.*		
129	6	Outside diameter	2.1649 to 2.1654 in.	(*)
129	6	Diameter of bearing bores in retainer.	2.1653 to 2.1659 in.	(*)
129	6	Inside diameter	1.8107 to 1.1811 in.	(*)
129	6	Diameter of hubs on carrier and motor driven gear.	1.1800 to 1.1814 in.	(*)
		b. OVERLOAD CLUTCH ASSEMBLY.		
		(1) *Clutch shaft spring end bearing.*		
129	1	Outside diameter	1.5743 to 1.5748 in	(*)
129	1	Diameter of bore in housing	1.5747 to 1.5752 in.	(*)
129	1	Inside diameter	0.6690 to 0.6693 in.	(*)
129	1	Diameter of clutch-gear shaft	0.6692 to 0.6695 in.	(*)

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		(2) *Clutch shaft gear end bearing.*		
129	13	Outside diameter	1.8499 to 1.8504 in.	(*)
129	13	Diameter of bore in housing	1.8503 to 1.8509 in.	(*)
129	13	Inside diameter	0.7870 to 0.7874 in.	(*)
129	13	Diameter of clutch-gear shaft	0.7873 to 0.7877 in.	(*)
		(3) *Clutch spring.*		
129	2	Free length (approximate)	$2\frac{31}{32}$ in.	
129	2	Length under 665- to 715-lb load	$2\frac{7}{16}$ in.	
		(4) *Clutch gear shaft.*		
129	15	Diameter over 0.1728-in rolls	2.4363 to 2.4383 in.	(*)
129	15	Backlash with idler-shaft gear	0.001 to 0.003 in.	(*)
129	3	Diameter over 0.1200-in rolls	1.1125 to 1.1147 in.	(*)
129	3	Measurement between 0.090-in rolls in splines in clutch.	0.8323 to 0.8341 in.	(*)
		(5) Clutch needle bearing.		
129	5	Outside diameter of inner race	1.2500 to 1.2503 in.	(*)
129	5	Inside diameter of inner race	1.0000 to 1.0003 in.	(*)
129	5	Diameter of clutch-gear shaft	1.0002 to 1.0010 in.	(*)
129	5	Outside diameter of outer race	1.4995 to 1.5005 in.	(*)
129	5	Diameter of bore in clutch gear	1.4995 to 1.5005 in.	(*)
		(6) *Clutch gear thrust washer.*		
129	14	Thickness	0.120 to 0.125 in.	(*)
		(7) *Clutch gear.*		
129	4	Diameter over 0.1728-in rolls	4.4386 to 4.4411 in.	(*)
129	4	Backlash with carrier gear	0.001 to 0.003 in.	
		c. Idler Shaft Assembly.		
		(1) *Idler shaft bearings.*		
129	16	Outside diameter	1.8499 to 1.8504 in.	(*)
129	16	Diameter of bores in housing	1.8503 to 1.8509 in.	(*)
129	16	Inside diameter	0.7870 to 0.7874 in.	(*)
129	16	Diameter of idler shaft	0.7873 to 0.7877 in.	(*)
		(2) *Idler shaft gear.*		
129	15	Diameter over 0.1728-in rolls	4.4386 to 4.4411 in.	(*)
129	15	Backlash with clutch-gear shaft	0.001 to 0.003 in.	(*)
		(3) *Idler pinion.*		
129	17	Diameter over 0.216-in rolls	2.5449 to 2.5469 in.	(*)
129	17	Backlash with output-shaft gear	0.001 to 0.003 in.	(*)
		d. Output Shaft Assembly.		
		(1) *Smaller output shaft ball bearing.*		
129	22	Outside diameter	2.0467 to 2.0472 in.	(*)
129	22	Diameter of bore in retainer	2.0467 to 2.0472 in.	(*)
129	22	Inside diameter	0.9839 to 0.9843 in.	(*)
129	22	Diameter of output shaft	0.9840 to 0.9846 in.	(*)

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		(2) *Output shaft gear.*		
129	17	Diameter over 0.216-in rolls	4.5482 to 4.5507 in.	(*)
129	17	Backlash with idler pinion	0.001 to 0.003 in.	(*)
		(3) *Larger output shaft ball bearing.*		
129	21	Outside diameter	2.4404 to 2.4409 in.	(*)
129	21	Diameter of bore in housing	2.4408 to 2.4414 in.	(*)
129	21	Inside diameter	1.3775 to 1.3780 in.	(*)
129	21	Diameter of output shaft	1.3779 to 1.3784 in.	(*)
		(4) *Needle bearing.*		
129	18	Outside diameter of inner race	1.3745 to 1.3750 in.	(*)
129	18	Inside diameter of inner race	1.1875 to 1.1877 in.	(*)
129	18	Diameter of output shaft	1.1877 to 1.1880 in.	(*)
129	18	Outside diameter of outer race	1.6245 to 1.6250 in.	(*)
129	18	Diameter of bore in housing	1.6235 to 1.6245 in.	(*)
		(5) *Output gear and lash compensating pinion.*		
129	19	Diameter over 0.3456-in rolls	3.5525 to 3.5544 in.	(*)
129	19	Backlash with turret ring gear	0.002 in min	(*)

Note. Adjust backlash of output gear with turret ring gear as outlined in paragraph 59. Lash compensating pinion takes up lash due to eccentricity of ring gear.

		(6) *Lash compensating pinion needle bearings.*		
129	20	Outside diameter of outer race	1.2495 to 1.2505 in.	(*)
129	20	Diameter of bore in pinion	1.2495 to 1.2505 in.	(*)
129	20	Diameter at pinion-needle-bearing area.	0.9995 to 1.0000 in.	(*)
		e. Drive Gear Assembly.		
		(1) *Drive gear.*		
129	7	Diameter over 0.144-in rolls	2.1957 to 2.1977 in.	(*)
129	7	Backlash with motor driven gear	0.001 to 0.003 in.	(*)
		(2) *Bearing at motor end.*		
129	9	Outside diameter	1.6530 to 1.6535 in.	(*)
129	9	Diameter of bore in bracket	1.6534 to 1.6539 in.	(*)
129	9	Inside diameter	0.7870 to 0.7874 in.	(*)
129	9	Diameter of drive gear	0.7866 to 0.7870 in.	(*)
		(3) *Bearing at gear end.*		
129	8	Outside diameter	1.8499 to 1.8504 in.	(*)
129	8	Diameter of bore in bracket	1.8504 to 1.8510 in.	(*)
129	8	Inside diameter	0.9839 to 0.9843 in.	(*)
129	8	Diameter of drive gear	0.9844 to 0.9846 in.	(*)
		f. Motor Driven Gear Assembly.		
129	7	Diameter over 0.144-in rolls	3.2789 to 3.2809 in.	(*)
129	7	Backlash with drive gear	0.001 to 0.003 in.	(*)

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
g. HYDRAULIC LOCKING CYLINDER ASSEMBLY.				
		(1) *Plunger.*		
129	12	Diameter of pilot end of plunger	0.3740 to 0.3745 in	(*)
129	12	Diameter of bore in cylinder	0.375 to 0.376 in	(*)
129	11	Large diameter of plunger	1.2460 to 1.2465 in	(*)
129	11	Diameter of large bore in cylinder	1.250 to 1.251 in	(*)
		(2) *Spring.*		
129	10	Free length (approximate)	1¾ in	
129	10	Length under 11.7- to 14.3-lb load.	1½ in	
h. HAND CRANK AND NO-BACK ASSEMBLY.				
		(1) *Handle spring.*		
130	1	Free length (approximate)	6⅝ in	
130	1	Length under 18- to 22-lb load	4$^{9}/_{16}$ in	
		(2) *No-back assembly.*		
130	8	Outside diameter	2.8341 to 2.8346 in	(*)
130	8	Diameter of bore in housing	2.8346 to 2.8354 in	(*)

Note. No-back assembly is serviced and replaced as a unit. See par. 11*b*(3).

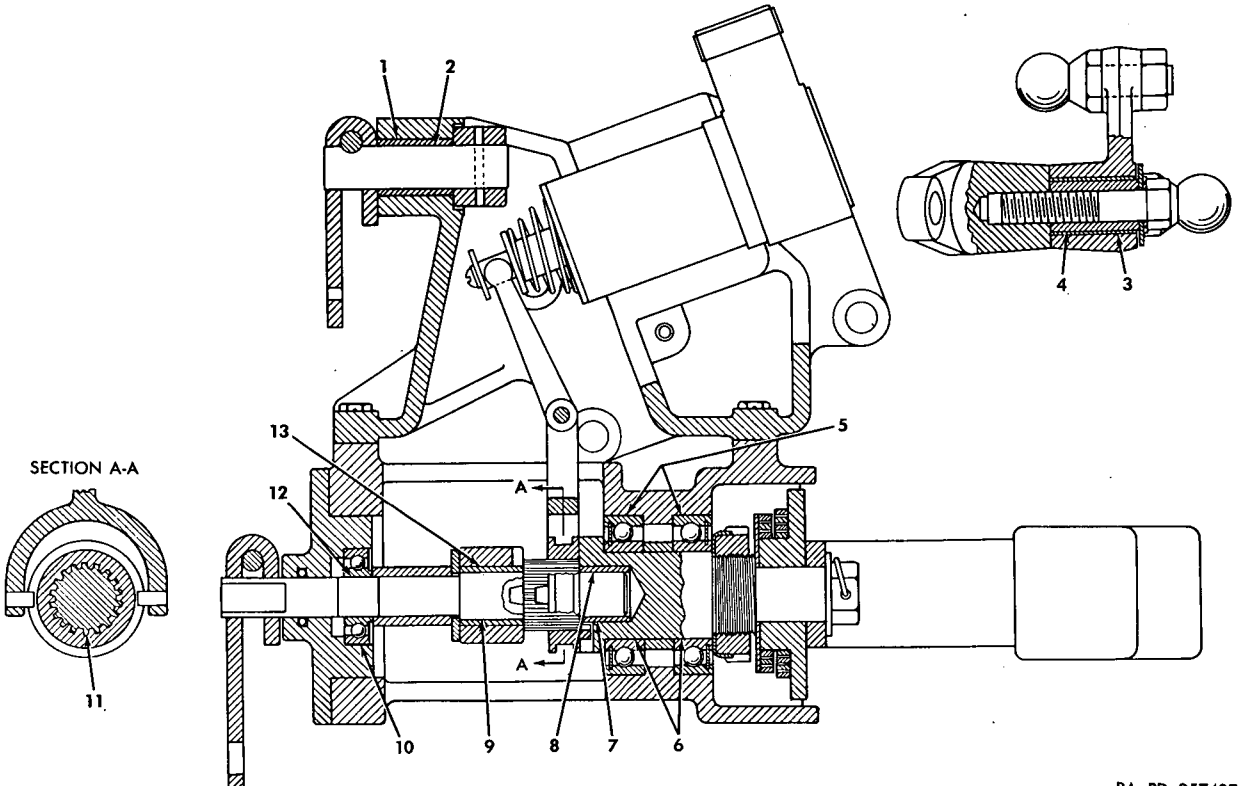


Figure 131. Serviceability standards points of measurement for Gunner's shifter control and control-link lever assembly.

71. Gunner's and Commander's Traverse Controls
(Ch. 4, sec. II)

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		a. GUNNER'S TRAVERSE CONTROL.		
		(1) *Crank pin bushing.*		
131	1	Outside diameter	0.628 to 0.629 in.	(*)
131	1	Diameter of bore in bracket	0.625 to 0.626 in.	(*)
131	2	Inside diameter	0.5015 to 0.5025 in.	(*)
131	2	Diameter of crank pin	0.499 to 0.500 in.	(*)
		(2) *Shifter control shift bearings and bushing.*		
131	5	Outside diameter	1.8499 to 1.8504 in.	(*)
131	5	Diameter of bore in body	1.8503 to 1.8509 in.	(*)
131	6	Inside diameter	0.9839 to 0.9843 in.	(*)
131	6	Diameter of control shaft at right bearing.	0.9836 to 0.9840 in.	(*)
131	6	Diameter of control shaft at left bearing.	0.9842 to 0.9846 in.	(*)
131	7	Outside diameter	0.6265 to 0.6275 in.	(*)
131	7	Diameter of bore in shaft	0.625 to 0.626 in.	(*)
131	8	Inside diameter	0.5005 to 0.5015 in.	(*)
131	8	Diameter of shifter shaft	0.4985 to 0.4995 in.	(*)
		(3) *Control lever bushing.*		
131	13	Outside diameter	0.688 to 0.689 in.	(*)
131	13	Diameter of bore in lever	0.6865 to 0.6875 in.	(*)
131	9	Inside diameter	0.563 to 0.564 in.	(*)
131	9	Diameter of shifter shaft	0.5615 to 0.5625 in.	(*)
		(4) *Shifter cap bearing.*		
131	10	Outside diameter	1.1020 to 1.1024 in.	(*)
131	10	Diameter of bore in cap	1.1023 to 1.1028 in.	(*)
131	12	Inside diameter	0.4721 to 0.4724 in.	(*)
131	12	Diameter of shifter shaft	0.4723 to 0.4726 in.	(*)
		(5) *Solenoid shifter lever pins.*		
131	11	Clutch must move freely on shifter shaft without binding or looseness.		
		b. CONTROL LINK LEVER ASSEMBLY.		
131	3	Outside diameter	0.687 to 0.688 in.	(*)
131	3	Diameter of bore in lever	0.687 to 0.688 in.	(*)
131	4	Inside diameter	0.625 to 0.627 in.	0.630 in.
131	4	Diameter of lever spacer	0.614 to 0.624 in.	(*)

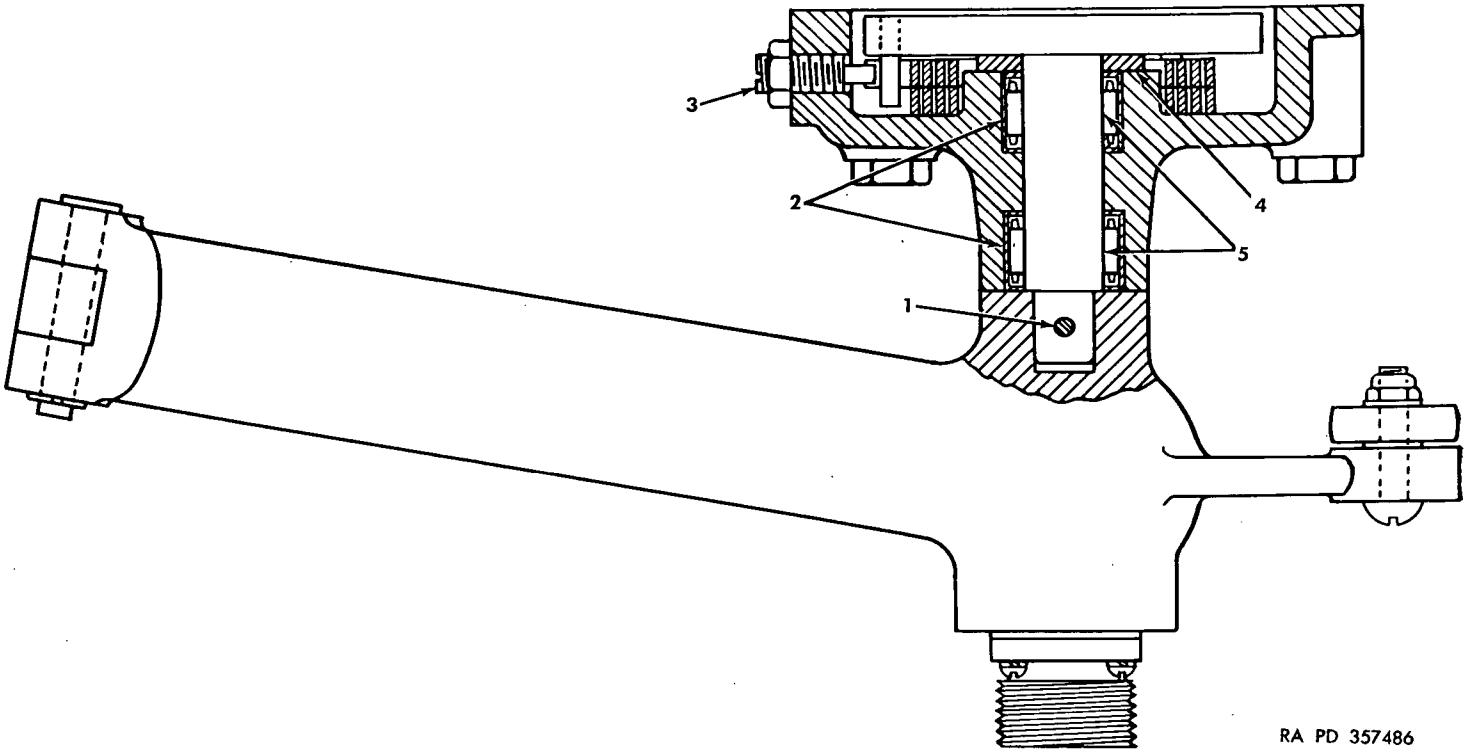


Figure 132. Serviceability standards points of measurement for commander's control.

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		c. COMMANDER'S TRAVERSE CONTROL.		
		(1) *Lever assembling pin.*		
132	1	Assemble handle to centering-spring housing with one adjusting screw at three degrees, 44 minutes and other screw at 130 degrees from horizontal centerline of handle.		
		(2) *Housing needle bearings.*		
132	2	Outside diameter	0.6870 to 0. 6880 in.	(*)
132	2	Diameter of bores in housing	0.6870 to 0.6880 in.	(*)
132	5	Diameter of shaft	0.4995 to 0.5000 in.	(*)
		(3) *Thrust washer.*		
132	4	Thickness	0.0912 to 0.0962 in.	(*)
		(4) *Spring centering adjusting screw.*		
132	3	Adjust for zero play in handle in both directions.		

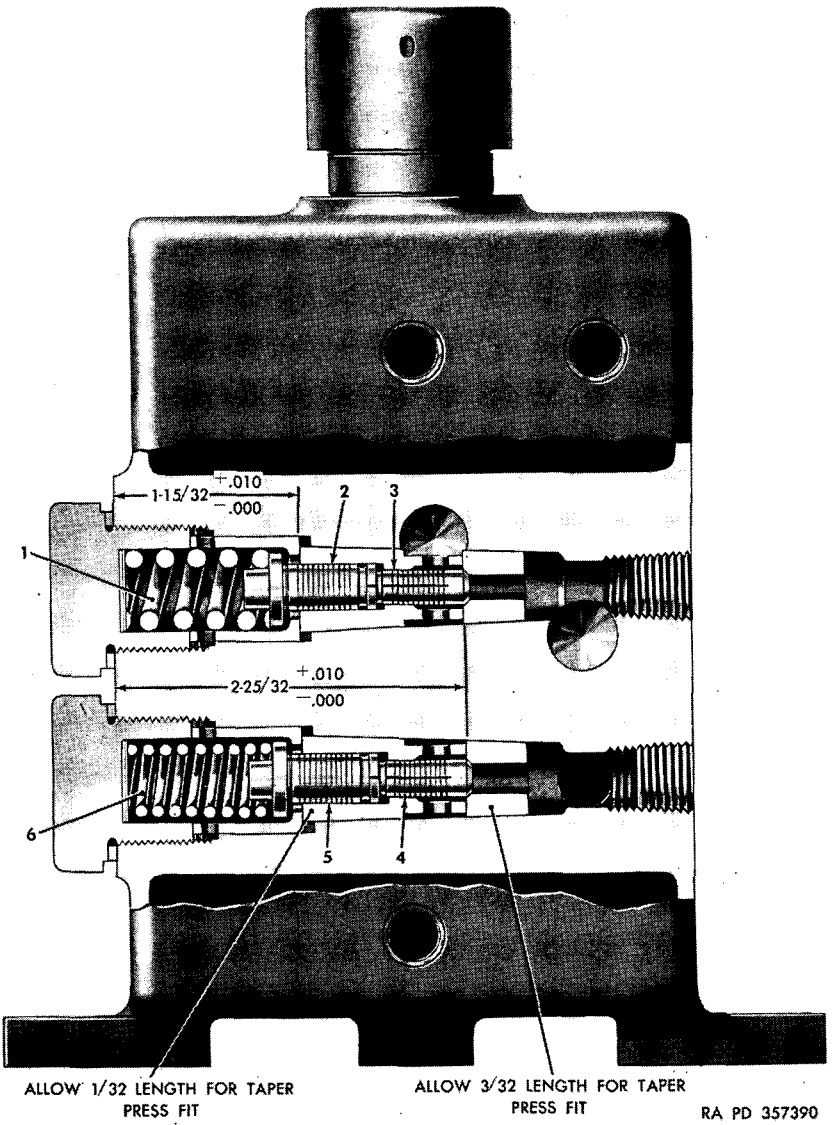


Figure 133. Serviceability standards points of measurement for relief valves.

Fig. No.	Ref. No.	Point of measurement	Size and fits of new parts	Wear limits
		a. PUMP HIGH-PRESSURE RELIEF VALVE.		
		(1) *Spring.*		
133	1	Free length (approximate)	1 3/32 in	
133	1	Length under 360- to 390-lb load	0.875	0.860 in at 360-lb load.
		(2) *Plunger.*		
133	2	Diameter of large end	0.3745 to 0.3747 in	(*)
133	2	Diameter of bore in bushing	0.3748 to 0.3750 in	(*)
		Note. Select for 0.0003-to 0.0005-in loose fit.		
133	3	Diameter of small end	0.2640 to 0.2645 in	(*)
133	3	Diameter of bore in bushing	0. 2651 to 0.2656 in	(*)
		b. GEAR PUMP RELIEF VALVE.		
		(1) *Plunger.*		
133	5	Diameter of large end	0.3745 to 0.3747 in	(*)
133	5	Diameter of bore in bushing	0.3748 to 0.3750 in	(*)
		Note. Select for 0.0003-to 0.0005-in loose fit.		
133	4	Diameter of small end	0.2640 to 0.2645 in	(*)
133	4	Diameter of bore in bushing	0.2651 to 0.2656 in	(*)
		(2) *Spring.*		
133	6	Free length (approximate)	1 21/64 in	
133	6	Length under 4.22- to 4.65-lb load	1 in	31/32 in. at 4.22-lb load.

APPENDIX

REFERENCES

1. Publication Indexes

The following publication indexes and lists of current issue should be consulted frequently for latest changes or revisions of references given in this appendix and for new publications relating to matériel covered in this manual:

a. Index of Administrative Publications	SR 310–20–5
b. Index of Army Motion Pictures and Film Strips	SR 110–1–1
c Index of Army Training Publications	SR 310–20–3
d. Index of Blank Forms and Army Personnel Classification Tests	SR 310–20–6
e. Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, Tables of Equipment, and Tables of of Basic Allowances	SR 310–20–4
f. Introduction and Index (supply catalogs)	ORD 1
g. Military Training Aids	FM 21–8

2. Supply Catalogs

The following catalogs of the Department of the Army Supply Catalog pertain to this matériel:

a. MAINTENANCE AND REPAIR.

Antifriction Bearings and Related Items	ORD 5 SNL H–12
Cleaners, Preservatives, Lubricants, Recoil Fluids, Special Oils, and Related Maintenance Materials	ORD 3 SNL K–1
Items of Soldering, Metallizing, Brazing and Welding Materials: Gases and Related Items	Ord 3 SNL K–2
Lubricating Equipment, Accessories, and Related Dispensers	ORD (*) SNL K–3
Miscellaneous Hardware	ORD 5 SNL H–2

*See ORD 2, Introduction and Index, for published catalogs of the ordnance section of the Department of the Army Supply Catalog.

Oil Seals	ORD 5 SNL H–13
Ordnance Maintenance Sets	ORD 6 SNL N–21
Pipe and Hose Fittings	ORD 5 SNL H–6
Standard Hardware	Ord 5 SNL H–1
Tool-Sets (special), Motor Vehicles	ORD 6 SNL G–27, Sec 1
Tool-Sets (common), Specialists' and Organizational	ORD 6 SNL G–27, Sec 2

b. VEHICLE.

Tank, medium, M46 (T40)	ORD (*) SNL G–2A4

3. Other Publications

The following publications contain information pertinent to this matériel and associated equipment.

a. CAMOUFLAGE.

Camouflage	TM 5–267
Camouflage, Basic Principles	FM 5–20
Camouflage of Vehicles	FM 5–20B

b. DECONTAMINATION.

Decontamination	TM 3–220
Decontamination of Armored Force Vehicles	FM 17–59

c. GENERAL.

Dictionary of United States Army Terms	TM 20–205
General Safety Manual	TM 20–350
Inspection of Ordnance Matériel	TM 9–1100

4. Forms

DA AGO Form 9–71, Locator and Inventory Control Card
DA AGO Form 9–72, Ordnance Stock Record Card
DA AGO Form 9–76, Request for Work Order
DA AGO Form 9–77, Job Order Register
DA AGO Form 9–78, Job Order
DA AGO Form 9–79, Parts Requisition
DA AGO Form 9–80, Job Order File
DA AGO Form 9–81, Exchange Part or Unit Identification Tag
DA AGO Form 461–5, Limited Technical Inspection
DA AGO Form 468, Unsatisfactory Equipment Report
DA AGO Form 865, Work Order
DA AGO 866, Consolidation of Parts
DA AGO Form 867, Status of Modification Work Order

*See ORD 1, Introduction and Index, for published catalogs of the ordnance section of the Department of the Army Supply Catalog.

d. Maintenance and Repair.

Basic Maintenance Manual	TM 38–650
Cleaning, Preserving, Sealing, and Related Materials Issued for Ordnance Matériel	TM 9–850
Hand, Measuring, and Power Tools	TM 10–590
Instruction Guide: Care and Maintenance of Ball and Roller Bearings	TM 37–265
Lubrication	TM 9–2835
Maintenance and Care of Hand Tools	TM 9–867
Modification of Ordnance Matériel	SB 9–38
Motor Vehicle Inspection and Preventive Maintenance Services	TM 37–2810
Ordnance Maintenance: Carburetors (Stromberg)	TM 9–1826B
Ordnance Maintenance: Continental 12-Cylinder Engine, Model AV–1790–5A	TM 9–1718A
Ordnance Maintenance: Cross-Drive Transmission, Model CD–850–3 (Allison–GM)	TM 9–1718B
Ordnance Maintenance: Electrical Equipment (Bendix-Scintilla)	TM 9–1825E
Ordnance Maintenance: Electrical Equipment (Eclipse-Pioneer)	TM 9–1825C
Ordnance Maintenance: Electrical Equipment (Westinghouse)	TM 9–1825D
Ordnance Maintenance: Fuel Pumps	TM 9–1828A
Ordnance Maintenance: Vehicular Maintenance Equipment: Grinding, Boring, Valve Reseating Machines and Lathes	TM 9–1834A
Ordnance Maintenance: Wisconsin 2-Cylinder Auxiliary Engine, Model TFT	TM 9–1718C
Painting Instructions for Field Use	TM 9–2851
Preventive Maintenance of Electric Motors and Generators	TM 55–405

e. Operation.

Lubrication Order	LO 9–718
Medium Tank M46	TM 9–718

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